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Proceedings

Brooklyn Engineers Club

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W. H. Roberts

BROOKLYN ENGINEERS' CLUB

**ORGANIZED OCT. 9, 1896.
INCORPORATED DEC. 29, 1896.**

PROCEEDINGS FOR 1911

CONSTITUTION AND BY-LAWS

AND

**ANNUAL REPORT OF THE BOARD OF
DIRECTORS**

PRICE, TWO DOLLARS

Published by the **BROOKLYN ENGINEERS' CLUB**,
Office of Secretary and Library of Club in the Club House,
117 Remsen Street, Brooklyn, New York.

JANUARY, 1912

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May 6. 1914

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BROOKLYN ENGINEERS' CLUB.

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BROOKLYN ENGINEERS' CLUB.

CONSTITUTION AND BY-LAWS.

ARTICLE I.

NAME, LOCATION AND OBJECT.

SECTION 1. The name of this Association shall be the

"BROOKLYN ENGINEERS' CLUB."

SEC. 2. The offices of the Club shall be located in the Borough of Brooklyn.

SEC. 3. The object of the Club shall be to promote social and professional intercourse among its members; to advance engineering knowledge and practice, and to maintain a high standard of professional procedure in all respects.

SEC. 4. The means to be employed for this purpose shall be: Meetings for the presentation and discussion of appropriate papers and for social and professional intercourse; the publication of such papers and discussions as may be deemed expedient; the maintenance of a technical library, and such other means as may be deemed proper.

ARTICLE II.

MEMBERSHIP.

SECTION 1. The Club shall consist of Corporate, Associate, Non-Resident and Honorary members.

SEC. 2. A Corporate member shall be a civil, military, naval, mechanical, electrical, mining or other engineer, architect, surveyor or analytical chemist, or a person who has taken a course in a technical school with the purpose of entering one of the above-mentioned professions. He shall be either a resident of Brooklyn, or one of the other Boroughs of the City of New York, or a practitioner therein, at the time of his election.

SEC. 3. An Associate member shall be a person residing, or doing business in Brooklyn, or another Borough of the City of New York, at the time of making his application, who has such a knowledge of or connection with applied science as qualifies him, in the opinion of the Board of Directors, to co-operate with engineers in the advancement of professional knowledge.

SEC. 4. A Non-Resident member shall be one possessing the qualifications enumerated in Sections 2 and 3, whose residence is outside of the City of New York; Commissioned Engineer Officers in the Military or Naval service of the United States may be elected to this grade of membership.

SEC. 5. A Corporate or Associate member who shall remove his residence to the distance stated in Section 4, may be transferred to the Non-Resident class at the beginning of the fiscal year following such removal, provided notice of the removal be filed with the Secretary at the time of payment of the annual dues, or not later than February 1st.

SEC. 6. A Non-Resident member who shall remove his residence to within the City of New York, shall become a full member in the same manner as specified in Article III, but shall not be required to pay an entrance fee. Provided, however, that his application for full membership shall be filed within three (3) months of his removal, otherwise his name shall be dropped from the roll of the Club by the Board of Directors at the beginning of the next calendar year, except that no action shall be taken unless a copy of this section shall have been served upon him at least four (4) weeks prior to such action.

SEC. 7. Honorary members shall be chosen from persons resident in Brooklyn, of acknowledged eminence in the pursuit of their profession, or on account of their contributions to the welfare of the community along professional or municipal lines. There shall not be more than five (5) Honorary members at any one time.

SEC. 8. Associate, Non-Resident and Honorary members shall not be entitled to vote or hold office, but shall enjoy all other Club privileges.

ARTICLE III.

ADMISSIONS AND EXPULSIONS.

SECTION 1. An application for admission to the Club as a Corporate member or for transfer from the Non-Corporate to the Corporate grade, shall embody a concise statement, with dates, of the candidate's professional training and experience, and shall be in a form and in such detail as may be prescribed by the Board of Directors. It shall be signed by the applicant, and shall contain a promise to conform to the requirements of membership if elected. The applicant shall give at least three (3) references, two of whom shall be Corporate members in good standing.

SEC. 2. At the time of giving notice of the regular meetings of the Club, the Secretary shall issue to each member, in any grade, whose address is known, a list of all new applications received up to that time for member-

ship in any grade or for transfer from one grade to another, which list shall be dated and shall contain a statement of the name, address, and present employment of each applicant and the names of his references, with a request that members transmit to the Membership Committee any information in their possession which may affect the disposition of the applications.

Not less than twenty days after the date of issue of such list the Membership Committee shall make a report in writing upon each of these applications to the Board of Directors, who shall, at the next meeting, consider the reports received, and, if approved by them, shall direct a ballot.

SEC. 3. The ballots shall be letter ballots, in a form to be prescribed by the Board of Directors. They shall be mailed to each Corporate member whose address is known, and shall state the date on which the ballot is to be canvassed.

A four-fifths vote of those voting shall be necessary for election. In case of a candidate failing of election, no notice thereof shall be entered in the minutes, but the candidate shall be notified.

SEC. 4. The application of any candidate, once rejected, shall not be considered by the Board of Directors, within one year, unless the same be accompanied by a request signed by not less than five (5) Corporate members asking for a reconsideration of the ballot, and stating the reason for such request. The Board of Directors, should it deem those reasons sufficient, shall present said application at the next regular meeting of the Club, with the request that it be acted upon.

SEC. 5. All elected candidates shall be duly notified and shall subscribe to the Constitution and Rules of the Club.

If these provisions are not complied with within thirty (30) days from the notification of election, such election shall be considered void unless, for special reason, the time shall be extended by the Board of Directors. Membership of any person shall date from the day of his election.

SEC. 6. Honorary members shall be proposed by the Secretary upon the unanimous recommendation of the Board of Directors at a regular meeting, and be balloted upon at the next regular meeting. Four-fifths (4-5) of the votes cast shall be necessary for an election.

A person elected an Honorary member shall be promptly notified thereof by letter; the election shall be canceled if an acceptance is not received within ninety (90) days after mailing such notice.

SEC. 7. Upon the written request of six or more Corporate members, that for cause therein set forth a person belonging to the Club be expelled, the Board of Directors shall consider the matter, and if there appear to be sufficient reason, shall advise the accused of the charges against him. He

may, if he so desire, present a written defense, which shall be considered at a meeting of the Board of Directors, of which he shall receive due notice and at which he may appear with counsel. Unless the Defense made be satisfactory to the Board of Directors, they shall, after two months have elapsed, unless his resignation has already been tendered, notify the person that he must present the same within thirty (30) days, or he will then be expelled.

An appeal may be taken against such a course, in which case a special meeting will be called for the purpose of submitting to the Club all the evidence in the case. A majority of the votes cast at this special meeting will be required to sustain the action of the Board. The Secretary will notify all Corporate members of the Club of the result of the ballot. In case no appeal be made, the Board of Directors will expel the person, and notify him and the Corporate members of its action.

SEC. 8. A member of any grade in the Club may resign his membership by a written communication to the Secretary, who shall present the same to the Board of Directors; when, if his dues have been paid, his resignation will be accepted.

ARTICLE IV.

Entrance Fees and Dues.

SECTION 1. The dues on admission to the Club and yearly thereafter shall be:

For Corporate member, Twelve (12) Dollars.

For Associate member, Twelve (12) Dollars.

For Non-Resident member, Five (5) Dollars.

SEC. 2. Corporate, Associate and Non-Resident members shall pay an entrance fee of Ten (10) Dollars upon admission to the Club.

The annual dues shall be payable for the ensuing year on the first day of January.

It shall be the duty of the Secretary to notify each member of the amount due for the ensuing year at the time of giving notice of the annual meeting.

SEC. 3. A person elected after six months of any fiscal year shall have expired shall pay only one-half of the amount of dues for that fiscal year.

SEC. 4. Any person whose dues are more than one month in arrears shall be notified by the Secretary. Should his dues not be paid when they become three months in arrears, he shall lose all Library privileges secured through the membership in the Club, and lose his right to vote. Should his dues become four months in arrears he shall again be notified

in form prescribed by the Board of Directors, and should such dues become six months in arrears he shall forfeit his connection with the Club. The Board of Directors may, for cause deemed by them sufficient, extend the time for payment and for application of these penalties.

SEC. 5. Every member admitted to the Club shall be considered as belonging thereto, and liable for payment of dues until he shall have resigned or been expelled therefrom.

ARTICLE V.

Officers.

SECTION 1. The officers of the Club shall be a President, Vice-President, Secretary and Treasurer, who, with the retiring President, and two Corporate members elected by the Club, shall constitute a Board of Directors, in which the government of the Club shall be vested, and who shall be the Directors as provided for by the laws under which the Club is incorporated; there shall also be an Auditing Committee of three members.

SEC. 2. The President shall be ineligible for election to two successive terms of office.

SEC. 3. The term of office for all officers shall be one (1) year, except for the Vice-President, who shall hold office for two (2) years.

SEC. 4. A vacancy in the office of President shall be filled by the Vice-President.

SEC. 5. At the first annual meeting there shall be elected a Trustee, who shall act as a member of the Board of Directors and shall serve for one year. Any vacancy occurring in the Board by resignation, death or otherwise, shall be filled for the unexpired term by its remaining members.

SEC. 6. All officers shall be elected by ballot.

SEC. 7. The Board of Directors may appoint a Librarian.

ARTICLE VI.

Management.

SECTION 1. The President, acting under the direction of the Board of Directors, shall exercise a general supervision over the affairs of the Club. He shall preside at all business meetings of the club and Board of Directors at which he may be present, call special meetings when the same may be necessary, and appoint such committees as are herein provided for. He shall act as ex-officio member of all committees which he shall appoint.

SEC. 2. The Vice-President shall preside at business meetings in the absence of the President.

SEC. 3. The Board of Directors shall manage the affairs of the Club in conformity to the laws under which the Club is incorporated, and the provisions of this Constitution. They shall direct the investment and care of the funds of the Club; make appropriations for specific purposes; act upon applications for membership, as heretofore provided, and generally conduct the business of the Club. The Board of Directors shall make an annual report at the annual meeting, transmitting the reports of the Secretary, the Treasurer, the Auditing and other committees.

SEC. 4. The Secretary, under the direction of the President and the Board of Directors, shall be the executive officer of the Club. He shall keep a record of all business meetings. He shall notify the members of all meetings and postponements thereof, and of all other matters as directed by the President and the Board of Directors. It shall also be his duty to take charge of and preserve all papers read and discussed, and, when directed by the Board of Directors, prepare copies or abstracts of the same for publication.

He shall see that all moneys due the Club are collected and transferred to the Treasurer. He shall verify the correctness of all bills presented for payment and charge same to the proper appropriations. He shall have charge of the books of account of the Club, and shall furnish to the Board of Directors a statement of receipts and expenditures under their several headings annually and at such other times as the Board may direct. He shall conduct the correspondence of the Club and keep full record of the same. He shall perform such other duties as may from time to time be assigned to him by the Board of Directors.

SEC. 5. The Treasurer shall be the custodian of the funds of the Club. He shall receive all moneys collected by the Secretary, and deposit the same to the credit of the Club in such depository as may be directed by the Board of Directors. He shall pay all bills, duly approved, by check, countersigned by the President, and shall keep book accounts of his receipts and expenditures, which shall be at all times open to inspection by the Board of Directors. He shall present a monthly report to the Board showing the receipts and expenditures during the previous month and the balance in his hands at the time of making such report. He shall make an annual report to be presented to the Club by the Board of Directors.

SEC. 6. The Auditing Committee shall, at the close of the fiscal year, audit the accounts of the Secretary and of the Treasurer.

SEC. 7. The Librarian shall have direct charge of all books, periodicals, transactions and other publications contained in the Library, subject to the direction of the Library Committee.

SEC. 8. The President, within ten days after the annual meeting, shall appoint a House Committee of three, a Library Committee of three, a Committee on New Membership of three, an Entertainment Committee of three, and an Excursion Committee of three members of the Club, which Committees shall be subject to the direction of the Board of Directors. All Committees shall hold office until their successors are appointed.

SEC. 9. The House Committee shall have general charge of the House and of the renting of such rooms as may be available for that purpose.

It shall arrange and provide for all Dinners, Collations or other social functions that may be held under Club auspices.

It shall act as a Reception Committee at all meetings of the Club, insuring visitors proper attention.

SEC. 10. The Library Committee shall have general charge of the Library, and shall take the necessary steps to procure all books, periodicals, transactions, reports, publications, etc., etc., that may be needed; present prior to the annual meeting a report to the Board of Directors, showing the increase in the Library during the year, and a statement of the moneys expended; also present an estimate of the moneys needed for Library purposes for the coming year.

SEC. 11. The Committee on New Membership shall investigate the fitness of all candidates for membership that may be referred to them by the President, see that the objects and advantages of the Club are at all times kept before the community in a proper spirit, and, generally, see that the Club preserves a healthy and desirable growth.

SEC. 12. The Entertainment Committee shall provide suitable papers to be presented before the Club at its regular meetings, and speakers for the Informal or Library Talks on such other dates as may be desirable.

SEC. 13. The Excursion Committee shall arrange and provide for all excursions, outings, or inspection trips of the Club and shall notify the Secretary in time for ample notice to the membership of such arrangements.

SEC. 14. The Secretary and the Librarian shall receive such compensation for their services as the Board of Directors may determine; but such compensation, when fixed, shall not be reduced during the term of office, as provided in this Constitution. All other salaries shall be fixed, from time to time, by the Board of Directors.

ARTICLE VII.

MEETINGS.

SECTION 1. There shall be eight (8) regular meetings of the Club per annum, to be held on the second Thursday in each month, except during the months of June, July, August and September.

SEC. 2. The annual meeting, at which the officers for the ensuing year shall be elected and all annual reports read, shall be held on the second Thursday in December in each year.

SEC. 3. Whenever the President shall deem it necessary, or upon the written application of five (5) Corporate members, he shall direct the Secretary to call a special meeting. The notice thereof shall state the time and place of holding the meeting and the purpose for which it is called, and shall be mailed not less than five days previous to the date of the proposed meeting.

SEC. 4. At all regular and special meetings of the Club, ten (10) Corporate members shall constitute a quorum.

SEC. 5. The Club may adopt, from time to time, rules for the order of business at its meeting.

SEC. 6. At the regular or special meeting of October, 1897, and annually thereafter, a committee of five (5) Corporate members shall be elected by the members present to make nominations for officers to be balloted for at the ensuing annual election. Said Committee shall report their list of nominations at the regular meeting in November, and the list shall be sent to each Corporate member by the Secretary, in the regular notification of the annual meeting. And it shall be the duty of the Secretary to send with such nominations any other nominations, on the written request of five (5) Corporate members filed with him ten (10) days before the date of the annual meeting. The said notices shall be mailed by the Secretary one week before the annual election.

In the event of failure to elect a Nominating Committee at an October meeting, it shall be the duty of the Board of Directors to appoint such committee.

ARTICLE VIII.

AMENDMENTS.

SECTION 1. Proposed amendments to this Constitution must be reduced to writing and signed by not less than five (5) Corporate members, and be submitted and acted upon as follows:

SEC. 2. The amendment, as proposed, shall be sent by letter to the several Corporate members, with the statement that the matter will come up before the next regular meeting for discussion unless otherwise ordered.

SEC. 3. At the discussion the proposed amendment may be amended in any way by a majority of those present and voting.

SEC. 4. The amendment, as amended, shall then be sent by letter to the several Corporate members, wherein the meeting for final action thereon will be announced. When final action is taken, a two-thirds (2-3) vote in favor of said amendment, as amended, will be necessary for its adoption.

FIRST OFFICERS, PAST PRESIDENTS AND CHARTER MEMBERS.*Temporary President, ANDREW J. PROVOST, JR.**Temporary Secretary, WILLIAM G. FORD.**Temporary Treasurer, GEORGE W. TILLSON.**Committee on Constitution and By-Laws and Committee on Library:*

*A. J. CALDWELL, GEORGE W. TILLSON, WALTER M. MESEROLE,
 A. J. PROVOST, JR., WILLIAM G. FORD.

Committee on Incorporation:

A. J. PROVOST, JR., WILLIAM G. FORD.

PAST PRESIDENTS.

*Andrew J. Caldwell, 1897.	Richard S. Buck, 1905.
Nelson P. Lewis, 1898.	Willard S. Tuttle, 1906.
Walter M. Meserole, 1899.	Clarence D. Pollock, 1907.
George W. Tillson, 1900.	George C. Whipple, 1908.
Joseph Strachan, 1901.	James C. Meem, 1909.
William G. Ford, 1902.	George A. Orrok, 1910.
Andrew J. Provost, Jr., 1903.	Winfred H. Roberts, 1911.
*Othniel F. Nichols, 1904.	

CHARTER MEMBERS.

O. F. Balston,	John H. Dwyer,
Fred. L. Bartlett,	William G. Ford,
Homer L. Bartlett,	Edwin J. Fort,
Herbert J. Barker,	Arthur J. Griffin,
W. L. Beers,	Thomas S. Griffin,
R. T. Betts,	Walter R. Griffith,
William E. Belknap,	George T. Hammond,
Francis Blossom,	Arthur S. Ives,
J. C. Brackenridge,	Carl A. Johnson,
David Brower,	Jacob Stinman Langthorn,
*William T. Bruorton,	J. Calvin Locke,
Edmund J. Burke,	Edward L. Maltby,
*Andrew J. Caldwell,	James C. Meem,
D. Frederick Carver,	Walter M. Meserole,
Frank J. Conlon.	*Peter Milne,
Albert S. Crane,	Frank O. Nowaczek,
Frederick A. Drake,	Arthur I. Perry.

*Deceased.

Frederick E. Pierce,	Kenneth Torrance,
Clarence D. Pollock,	Arthur S. Tuttle,
Andrew J. Provost, Jr.,	William D. Vanderbilt,
*G. S. Roberts,	*John H. Van der Veer,
George F. Rowell,	Bernard M. Wagner,
Joseph Strachan,	E. Sherman White,
Edwin C. Swezey,	Richard L. Williams,
George W. Tillson,	George E. Winslow.

OFFICERS, 1911.

President: WINFRED H. ROBERTS.

Vice-President: JOHN M. STEINMETZ.

Secretary: JOSEPH STRACHAN.

Treasurer: WILLIAM T. DONNELLY.

Auditing Committee: { JOHN C. SHERIDAN,
CHARLES R. WARD,
PERCY C. BARNEY.

BOARD OF DIRECTORS.

WINFRED H. ROBERTS,	WILLIAM T. DONNELLY,
JOHN M. STEINMETZ,	HERBERT C. KEITH,
JOSEPH STRACHAN,	WALTER F. WELLS.
GEORGE A. ORRICK.	

STANDING COMMITTEES.

Library: E. M. VAN NORDEN, J. J. JOHNSON, G. A. HUGHES.

House: J. B. STEIN, E. M. FRENCH, R. C. STRACHAN.

Membership: C. S. DUNPHE, W. P. HOUGH, W. E. SPEAR.

Entertainment: G. L. KNIGHT, H. R. COBLEIGH, N. C. ROCKWOOD.

Excursion: C. A. ANGELL, J. F. SCANLON, E. L. HUBBARD.

SPECIAL COMMITTEES.

Press: F. T. SLOAN, G. S. TAYLOR.

Publication: C. A. SOMNER.

Librarian: FRANK T. CONLON.

*Deceased.

OFFICERS, 1912.*President:* WILLIAM T. DONNELLY.*Vice-President:* JOHN M. STEINMETZ.*Secretary:* JOSEPH STRACHAN.*Treasurer:* JAMES W. NELSON.*Director:* HENRY W. WOODCOCK.*Director:* E. M. VAN NORDEN.

Auditing Committee: { R. L. WILLIAMS,
W. W. BRUSH,
H. P. MORAN.

BOARD OF DIRECTORS.

WILLIAM T. DONNELLY,

JAMES W. NELSON,

JOHN M. STEINMETZ,

HENRY W. WOODCOCK.

JOSEPH STRACHAN,

E. M. VAN NORDEN.

GEORGE A. ORBOK.

STANDING COMMITTEES.*Library:* E. M. VAN NORDEN, G. A. HUGHES, C. M. ENDERBY.*House:* J. B. STEIN, C. W. MCINENLY, W. E. McLAUGHLIN.*Membership:* J. C. MEEM, H. P. MORGAN, J. T. HORTON.*Entertainment:* N. C. ROCKWOOD, G. A. ORBOK, H. R. COBLEIGH.*Excursion:* D. W. BARNES, C. A. GRAVES, G. W. EISENBRAUN.**SPECIAL COMMITTEES.***Committee on Award of The Alfred T. White Prize:* A. S. TUTTLE, J. S. LANGTHORN, W. W. MACON.*Advisory Committee on Publication of Proceedings:* J. W. NELSON, H. R. COBLEIGH, E. A. SIMMONS.*Press:* F. T. SLOAN, G. S. TAYLOR.*Business Manager, Proceedings for 1911:* C. A. SOMNER.

**PAST AND PRESENT OFFICERS AND THE YEARS DURING
WHICH THEY HELD OFFICE.**

Name.	President.	Vice-President.	Secretary.	Treasurer.	Director.	Librarian.	Auditing Committee.
Andrews, William.....					1910		
Barney, Percy C.....							1911
Brush, Wm. W.....							1912
Buck, Richard S.....	1905				1906		
*Caldwell, Andrew J....	1897				1898		
Carmalt, Laurance J....					1906		
Conlon, Frank J.....						1907-11	
Cranford, Frederick L..							1910
Donnelly, Wm. T.....	1912			1908-11			
Ford, Wm. G.....	1902			1897-98	1903		
Fort, Edwin J.....					1908		
Hartung, Geo. A.....							1910
Keith, Herbert C.....					1911		
Lewis, Nelson P.....	1898				1899		
Martin, Kingsley L....		1907-08			1906		
Meem, James C.....	1909				1907 & 10		
Meserole, Walter M....	1899	1897-98			1900		
Middleton, John.....				1903-07			
Moran, Harry P.....							1912
Nelson, James W.....				1912	1908-09		
*Nichols, Othniel F....	1904				1905		
Noble, Frederick C.....					1910		
Orrok, George A.....	1910				1911		
Perry, Arthur I.....						1901-04	
Pollock, Clarence D....	1907	1905-06			1908		
Provost, Andrew J., Jr.	1903		1897-02		1904		
Rice, Calvin W.....				1899-00			
Roberts, Winfred H....	1911	1909-10					
Schmitt, Jacob.....						1905-06	1910
Seaman, Henry B.....		1899-00					
Shaler, E. Conway.....					1907		
Sheridan, John C.....							1911
Spofford, Chas. M.....					1909		
Steinmetz, John M.....		1911-12					
Strachan, Joseph.....	1901		1903-12		1902		
Tillson, Geo. W.....	1900				1901		
Torrance, Kenneth.....					1897		
Tuttle, Willard S.....	1906	1901-02			1907		
Van Norden, E. M.....					1912		
Ward, Charles R.....							1911
Wells, Walter F.....					1911		
Whipple, George C.....	1908			1901-02	1909		
Williams, R. L.....							1912
Woodcock, Henry W.....					1912		
Woodward, Frederick S..		1903-04					

* Deceased.

LIST OF MEMBERS.

ORGANIZED OCTOBER 9TH, 1896.

HONORARY MEMBER.

	Date of Election.
WHITE, ALFRED T., 40 Remsen St., Brooklyn, N. Y.....	May 12, 1893

CORPORATE MEMBERS.

ABRAITYS, GEORGE. With Public Service Commission, 64 Woodland Ave., Woodhaven, N. Y.....	April 11, 1912
AHRENS, HENRY. Structural Engineer, with Balcom & Darrow, 70 East 45th St., New York City.....	Oct. 11, 1906
AIKEN, CHARLES W. Sec. Treas., Houchin-Aiken Co., 35 53d St., Brooklyn, N. Y.....	May 14, 1908
ALLYN, ROBERT S. President, National Metal-Fabric Co., 16 Exchange Pl., New York City.....	Oct. 14, 1909
ANDERSON, ANDERS, 353 51st St., Brooklyn, N. Y.....	Oct. 11, 1906
ANDERSON, CHAS. M. With Edison Elec. Ill. Co., 265 Madison St., Brooklyn, N. Y.	Oct. 12, 1911
ANDREWS, WILLIAM. Consulting Engineer, 120 Liberty St., New York City.....	June 19, 1902
ANKENER, RICHARD. Transitman, Department of Water Supply, Gas and Electricity, Brooklyn, N. Y.....	Nov. 10, 1904
ARMSTRONG, JOHN E. Assistant Engineer, Empire City Subway Co., 603 Bloomfield Ave., West Nutley, N. J.	Oct. 14, 1909
ASHTON, WALTER. 268 Nichols Ave., Brooklyn, N. Y....	Feb. 8, 1912
BARKER, HERBERT J. Asst. Engr., Bureau of Highways, Municipal Bldg., Brooklyn, N. Y.....	Nov. 6, 1896
BARNES, DAVID W. Vice-Pres., Garwood Elec. Co., 149 Broadway, New York City	Nov. 14, 1907
BARNEY, PERCY C. Prin. Asst. Engr., Board of Water Supply, 165 Broadway, N. Y.....	Feb. 9, 1905
BARTLETT, FRED L. Civil Engineer and City Surveyor, 190 Montague St., Brooklyn, N. Y.....	Nov. 6, 1896
BARTLETT, HOMER L. Civil Engineer and City Surveyor, 191 Montague St., Brooklyn, N. Y.....	Nov. 6, 1896
BEATTIE, JAMES G. 581 Amersfort Place, Brooklyn, N. Y.	May 14, 1908
BERGER, BERNT. Civil Engineer, 45 Broadway, N. Y.....	April 1, 1897
BERNARD, MATTHIAS. With B. R. T. System, 85 Clinton St., Brooklyn, N. Y.	May 12, 1910

	Date of Election	
BERRY, GEORGE. Asst. Engineer, Bureau of Highways, 78 Morton St., Brooklyn, N. Y.....	Jan.	8, 1903
BIGLIN, THOS. Dept. Water Supply, Gas & Electricity, 77 State St., Brooklyn, N. Y.....	May	9, 1912
BIRRELL, GEORGE V. Transitman & Computer, Topo- graphical Bureau, 209 Montague St., Brooklyn, N. Y.	Oct.	14, 1909
BISCHOF, GEORGE J. Asst. Engineer, Borough President's Office, Brooklyn, 471 Ocean Parkway, Brooklyn, N. Y.	Oct.	14, 1909
BISSELL, CLINTON T. Structural & Electrical Engineer, Natl. Board of Fire Underwriters, 135 William St., N. Y.	Nov.	9, 1905
BLUNT, EDMUND H. With Electric Bond and Share Co., 71 Broadway, N. Y. City.....	Mar.	14, 1907
BLOUNT, IRVING. 43 Rugby Road, Brooklyn, N. Y.....	Feb.	8, 1906
BOOTH, WILLIAM L. Engineer, Division of Sub-struc- tures, Brooklyn, 941 Park Pl., Brooklyn, N. Y.....	May	13, 1909
BOYREER, WILLIAM C. With Public Service Commission, 154 Nassau St., N. Y.....	Jan.	10, 1901
BRACKENBRIDGE, J. C. Consulting Engineer, 95 Liberty St., N. Y. City	Nov.	6, 1896
BRAINE, LAWRENCE F. Vice-President, Rail Joint Co., 29 West 34th St., N. Y. City.....	Jan.	12, 1899
BRAINERD, J. WILLARD. Structural Engineer, 92 Lincoln Road, Brooklyn, N. Y.	Jan.	12, 1905
BROADHURST, WM. H. Chemist, Bureau of Highways, Municipal Bldg., Brooklyn, N. Y.....	Mar.	14, 1897
BROWER, DAVID. Assistant Engineer, Bureau of Sewers, Mechanics Bank Bldg., Brooklyn, N. Y.....	Nov.	6, 1896
BROWER, EDWARD S. 865 Park Pl., Brooklyn, N. Y.....	Jan.	14, 1904
BROWN, E. J. S. 123 East 23d St., N. Y.....	Oct.	12, 1911
BROWN, LEWIS P. 972 E. 12th St., Brooklyn, N. Y.....	May	10, 1906
BRUSH, WILLIAM W. Deputy Chief Engineer, Dept. Water Supply, Park Row Bldg, N. Y.....	Feb.	13, 1902
BUCK, RICHARD S. Sanderson & Porter, 52 William St., N. Y.	May	9, 1901
BUNDY, GEORGE L. P. O. Box 116, Hohokus, N. J.....	April	11, 1907
CAMPBELL, DANIEL, JR. Plan Examiner, Bureau of Buildings, Jackson Ave. and 5th St., Long Island City	April	13, 1905

	Date of Election.	
CARLIN, JOS. P. Secretary and Treasurer, P. J. Carlin Construction Co., 16 E. 23d St., N. Y.....	Nov.	10, 1904
CASSIDY, JOHN A. Transitman, Bureau of Highways, Municipal Bldg., Brooklyn, N. Y.....	Feb.	13, 1902
CHAPMAN, WILLIAM B. 50 Church St., New York City..	Nov.	14, 1907
CHEVALIER, WILLARD T. Asst. Engr., Public Service Commission, 23 Flatbush Ave., Brooklyn, N. Y....	Oct.	11, 1906
CLAUSNITZER, JOHN. 157 East 21st St., N. Y. City....	Jan.	8, 1903
COBLEIGH, HENRY R. 503 E. 8th St., Brooklyn, N. Y...	April	9, 1908
COLLINS, PETER J. Builder, 135 Westminster Road, Brooklyn, N. Y.	Mar.	11, 1909
COLLINS, RAYMOND R. Asst. Engineer, Dept. of Bridges, 1642 East 18th St., Brooklyn, N. Y.	May	9, 1912
CONLON, FRANK J. Asst. Engr., Bureau of Sewers, Mechanics Bank Bldg, Brooklyn, N. Y.....	Oct.	9, 1896
CONN, FRANK W. 81 Willoughby St., Brooklyn, N. Y...	April	13, 1899
CONWAY, W. J. 92 Second Pl., Brooklyn, N. Y.....	Feb.	10, 1910
COOMBS, ARTHUR W. 50 Church St., New York City...	Jan.	13, 1910
CRANE, ALBERT S. Hydraulic Engineer, with J. G. White & Co., 49 Exchange Pl., N. Y.....	Oct.	9, 1896
CRANFORD, FREDERICK L. Contractor, 177 Montague St., Brooklyn, N. Y.	Oct.	14, 1909
CRAVEN, MACDONOUGH. Consulting Engineer, 39 Cortlandt St., N. Y. City.....	Jan.	7, 1897
CROCKER, CALVIN I. Asst. Engineer, Dept. of Bridges, 84 Broadway, Brooklyn, N. Y.....	April	14, 1904
CRONIN, J. BARTH. Supt. and Engineer for Barth S. Cronin, 282 President St., Brooklyn, N. Y.....	Oct.	12, 1911
CROWELL, ROBERT R. Engineer in Charge, Topographical Bureau, Borough Hall, Long Island City.....	April	14, 1898
DARBEE, WM. Electric Bond and Share Co., 71 Broadway, N. Y. City	Feb.	4, 1897
DENNINGTON, FRED. C. City Surveyor, 204 Montague St., Brooklyn, N. Y.....	Feb.	11, 1904
DE RYSS, EMIL. Civil and Consulting Engineer. 68 West 68th St., N. Y.	Feb.	14, 1907
DE WILDE, ANDRIES. Genl. Manager, Harbor Dredging Co., 516 Nostrand Ave., Brooklyn, N. Y.	Nov.	9, 1911
DITMARS, HAROLD E. With McDermott & Hanigan, 31 W. 42d St., New York City.....	Jan	9, 1908

	Date of Election.	
DIXON, DE FOREST H. 169 Columbia Heights, Brooklyn, N. Y.	May	14, 1908
DODGE, FRANCIS D. Mfg. Chemist, 291 Henry St., Brooklyn, N. Y.	Oct.	13, 1910
DODGE, RICHARD D. 291 Henry St., Brooklyn, N. Y....	Feb.	8, 1900
DONALD, WM. H. 727 Quincy St., Brooklyn, N. Y.....	May	12, 1910
DONNELLY, J. A. Heating Engineer, 132 Nassau St., New York City	May	11, 1911
DONNELLY, WM. T. Consulting Engineer, Rooms 930-932-934, 17 Battery Pl., New York City.....	Oct.	13, 1904
DORON, CHARLES S. Asst. Engineer, Department of Parks, Brooklyn, N. Y.....	Jan.	14, 1909
DOUGHTY, GEORGE A. 710 Putnam Ave., Brooklyn, N. Y.	Jan.	9, 1908
DRAKE, FREDERICK A. Bureau of Highways, 446 80th St., Brooklyn, N. Y.....	Oct.	9, 1896
DREW, JOHN A. Engineer and Sales Manager, Worthington Hydraulic Works, 86 Liberty St., N. Y.....	Feb.	4, 1897
DREWETT, WILLIAM A. Superintendent, M. T. Davidson Co., 524 Lafayette Ave., Brooklyn, N. Y.....	Feb.	4, 1897
DUNCAN, JOHN H. Superintendent, with Barth S. Cronin, Brooklyn, N. Y.....	Jan.	12, 1911
DUNPHEE, CARROLL S. 212 East Third St., Brooklyn, N. Y.	Mar.	14, 1907
DWYER, JOHN H. Chief Engineer, Brighton Beach Improvement, Brooklyn Grade Crossing Commission, 906 Temple Bar, Brooklyn, N. Y.....	Nov.	6, 1896
EISENBAUN, GEO. W. Asst. Engineer, with W. T. Donnelly, 17 Battery Pl., New York City.....	April	14, 1910
ENDERBY, CLAUDE M. With Phoenix Construction Co., New York City	Jan.	12, 1911
ENNIS, WILLIAM D. Prof. Mechanical Eng., Polytechnic Institute, Brooklyn, N. Y.....	Jan.	8, 1908
ENTENMANN, PAUL M. With Public Service Commission, 317 6th Ave., Brooklyn, N. Y.....	April	11, 1912
EVANS, JOHN M. Civil Engineer, Cooper & Evans Company, General Contractors, 220 Broadway, N. Y....	Nov.	13, 1902
EVERS, C. RUDOLPH. 1138 Hancock St., Brooklyn, N. Y.	Jan.	9, 1908
FARMER, ALEXANDER S. Assistant Engineer, Board of Water Supply, New York City.....	Feb.	11, 1909
FISHER, FRANCIS D. Engineer for Degnon Contracting Co., 126 Columbia Heights, Brooklyn, N. Y.....	Jan.	12, 1905

	Date of Election	
FITZGERALD, EDW. T. 129 East 40th St., New York City.	April 14, 1910	
FLIFLET, THORLIEF. With Walter Kidder, Engineer Constructor, 140 Cedar St., New York City.....	April 14, 1910	
FORBES, ARTHUR C. Principal Asst. Engr., Topographical Bureau, Borough President's Office, Brooklyn, N. Y.	Feb. 13, 1902	
FORD, WILLIAM G. Consulting Engineer, 55 Liberty St., N. Y.	Oct. 9, 1896	
FORD, THOS. P. 465 E. 17th St., Brooklyn, N. Y.....	Jan. 13, 1910	
FORT, EDWIN J. Chief Engineer, Bureau of Sewers, Mechanics Bank Bldg., Brooklyn, N. Y.....	Nov. 6, 1896	
FOWLER, JOHN. 36 Vernon Ave., Brooklyn, N. Y.....	Oct. 8, 1908	
FOX, ARTHUR C. 175 Claremont Ave., N. Y. City.....	April 11, 1907	
FRENCH, EDMUND M., Asst. Engr., Topographical Bureau, 147 Remsen St., Brooklyn, N. Y.....	May 14, 1908	
FRENCH, JAMES B. Consulting Engineer, Room 1276, Hudson Terminal Bldg, 50 Church St., N. Y.....	Oct. 10, 1901	
FRIEDMAN, FERD. J. 18 E. 92d St., New York City....	Mar. 10, 1910	
FUNK, HARRY EDGAR. Asst. Engr., B. H. R. R. Co., 7 Spencer Pl., Brooklyn, N. Y.....	April 12, 1906	
GABRIEL, C. R. Consulting and Designing Engineer, E. W. Bliss Co., Brooklyn, N. Y.....	Jan. 9, 1908	
GELBERT, JOSEPH. Asst. Engr. with B. R. T., 85 Clinton St., Brooklyn, N. Y.	May 12, 1910	
GIBBONS, JAMES E. With Public Service Commission, 23 Flatbush Ave., Brooklyn, N. Y.....	Mar. 11, 1900	
GILL, STEPHEN J. P. Chief Engineer of Designing, Hudson Structural Steel Co. of N. Y., 157 Meserole Ave., Brooklyn, N. Y.	May 9, 1912	
GOLDING, THOS. W. Structural Engineer for Thomas Reilly, contractor and builder, 1616 Thompson St., Philadelphia. Pa.	Jan. 11, 1906	
GOODRIDGE, JOHN W. Engineer, The Cranford Co., 190 Montague St., Brooklyn, N. Y.....	Oct. 11, 1900	
GOODSELL, DANIEL B. 593 Riverside Drive, N. Y. City..	Mar. 12, 1908	
GRANGER, ABBOTT D. Contracting Engineer, A. D. Granger Co., 90 West St., N. Y.....	Feb. 4, 1897	
GRAVES, CARLETON A. 153 Bay 35th St., Brooklyn, N. Y.	Oct. 8, 1908	
GRAY, CLYDE D. Asst. Engr. with J. G. White & Co., 394 E. 21st St., Brooklyn, N. Y.....	Jan. 13, 1910	

	Date of Election.	
GREENFIELD, CHAS. Assistant Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	Oct.	14, 1909
GRIFFEN, WILLIAM J. City Surveyor, 737 East 31st St., Brooklyn, N. Y.	Mar.	14, 1912
GRIFFIN, ARTHUR J. Engineer of Construction, Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.....	Nov.	6, 1896
GRIFFIN, THOMAS S. Little Hocking, Ohio.....	Nov.	6, 1896
GRIFFITHS, JOHN D. Asst. Engineer, Dept. Water Supply, Gas and Electricity, Brooklyn, N. Y.....	Nov.	10, 1904
GRIFFITH, WALTER R. Asst. Engineer, Bureau of Public Buildings and Offices, Brooklyn, N. Y.....	Nov.	6, 1896
HAMILTON, JOHN W. Hamilton & Chambers, 29 Broadway, N. Y.	April	14, 1904
HAMMER, E. WALTER. Engineer with Thompson, Starrett Construction Co., Woolworth Bldg., N. Y. City.	April	13, 1911
HAMMOND, GEORGE T. Engineer of Sewer Design, 1011 Mechanics Bank Bldg., Brooklyn, N. Y.....	Oct.	9, 1896
HAMMOND, JOHN F. Hammond & Sloan, Inc., 16 Exchange Pl., N. Y.	Jan.	7, 1897
HANEY, LEWIS T. Cape Charles City, Va.....	May	12, 1904
HARDECKER, FRANK J. Structural Steel Draftsman, Dept. Bridges, New York City.....	Mar.	9, 1911
HARTUNG, GEO. A. Engineer, Ditmars & Brite, Architects, 111 Fifth Ave., N. Y.....	Nov.	10, 1904
HEAD, HENRY C. Asst. Engineer, Topographical Bureau, Brooklyn, N. Y.	Mar.	10, 1904
HEBERT, GEORGE W. Chief of Party, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	Jan.	14, 1909
HEDMAN, AXEL S. Architect, Arbuckle Bldg., Brooklyn, N. Y.	Feb.	11, 1904
HEGHINIAN, GARABED GEORGE. With Asphalt Construction Co., as Consulting Engineer, 418 Ave. C, West, Brooklyn, N. Y.	Feb.	12, 1903
HELWIG, ALFRED. 10th Ave. and 70th St., Brooklyn, N. Y.	Jan.	14, 1904
HINCKLEY, J. FRED. Chemical Engr., 550 East 7th St., Brooklyn, N. Y.	Mar.	13, 1902
HORTON, JOHN T. 276 Rugby Road, Brooklyn, N. Y....	May	14, 1908
HOUGH, CALVIN C. With H. C. Keith, Consulting Engineer, New York City	Feb.	9, 1911

	Date of Election	
HOUGH, FREDERICK L. Assistant Engineer with H. C. Keith, 116 Nassau St., N. Y. City.....	Jan.	14, 1909
HOUGH, WILLARD P. Chief Engineer, Pierson and Goodrich. Engineers and Contractors, 30 W. 38th St., N. Y. City	Oct.	12, 1905
HOWARD, CHAS. A. Manager, Turbine Department, E. W. Bliss Company, 180 W. 76th St., New York City.	Oct.	14, 1909
HUBER, LESLIE V. 1158 Forty-first St., Brooklyn, N. Y..	Oct.	12, 1911
HUGHES, GEO. A. N. Y. Edison Co., New York City....	April	14, 1910
HUNT, CHAS. A. 95 Hancock St., Brooklyn, N. Y.....	Feb.	10, 1910
IHLSENG, MAGNUS C. Municipal Civil Service Comm., 299 Bway, Room 1019, N. Y. City.....	Mar.	14, 1901
INGALLS, JAS. A. With Transit Development Co., Brooklyn, N. Y.	Jan.	12, 1911
JACOBI, CHAS. H. Asst. Engr., Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.....	Jan.	14, 1909
JENNINGS, J. EDWARD. 1469 Pacific St., Brooklyn, N. Y.	Oct.	11, 1906
JOHNSON, JOHN J. Transitman, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	Jan.	14, 1909
KANE, JASPER T. Mechanical Draftsman, Public Service Commission; 2012 Tribune Bldg., New York City.	April	10, 1902
KAUFMAN, GUSTAVE. Chief Engr., Kosmos Engineering Co., 26 Court St., Brooklyn, N. Y.....	Feb.	9, 1905
KEITH, HERBERT C. Consulting Engineer, 116 Nassau St., N. Y.	Feb.	8, 1906
KELLY, OLAF M. 84 Broadway, Brooklyn, N. Y.....	May	10, 1906
KENNEDY, DANIEL. President, The Kennedy Valve Mfg. Co., 57 Beekman St., N. Y.....	May	6, 1897
KENT, ROBERT SAYRE. Mechanical Engineer, 253 80th St., Brooklyn, N. Y.	Nov.	10, 1904
KIRBY, I. HENRY. Assistant Engineer, Bureau of Sewers. 215 Montague St., Brooklyn, N. Y.....	Oct.	12, 1899
KIRKHAM, HENRY P. With Brooklyn Union Gas Co., 610 6th St., Brooklyn, N. Y.....	Feb.	8, 1912
KNIGHT, GEO. H. 296 Ryerson St., Brooklyn, N. Y.....	April	9, 1908
KNIGHT, G. LAURENCE. Designing Engineer, Edison Elec. Ill. Co. of Brooklyn, N. Y.....	Feb.	8, 1906
KNOWLES, EDWARD R. Consulting Engineer, 1125 World Bldg, N. Y.	Oct.	13, 1904

	Date of Election.	
KOOP, FREDERICK W. Engr. in Charge, Division of Triangulation and Precise Levels, Board of Estimate and Apportionment, Room 401; 277 Broadway, N. Y.	Mar.	9, 1905
KRANTZ, HUBERT F. 160 Seventh St., Brooklyn, N. Y...	Mar.	8, 1906
LAFFERTY, JOHN W. Supt. of Distribution, Edison Elec. Ill. Co. of Brooklyn, 14 Rockwell Pl., Brooklyn, N. Y.	Mar.	12, 1908
LANCASTER, GEORGE Y. With N. Y. Board of Fire Underwriters, 81 Fort Greene Pl., Brooklyn, N. Y.....	Jan.	11, 1912
LANGLOTZ, CHARLES. Mechanical Superintendent, Brooklyn Cooperage Co., 888 Lincoln Pl., Brooklyn, N. Y.	April	1, 1897
LANGTHORN, J. S. With Board of Water Supply, 165 Broadway, New York City	Oct.	9, 1896
LEVITT, CHAS. A. With Empire Bridge Co., 570 Willoughby Ave., Brooklyn, N. Y.	Jan.	11, 1912
LEWIS, NELSON P. Chief Engineer, Board of Estimate and Apportionment, 277 Broadway, N. Y.....	June	24, 1897
LININGTON, FRANK W. Asst. to John Middleton, City Surveyor; 148 Arlington Ave., Brooklyn, N. Y.....	Jan.	10, 1907
LJUNG, FREDERICK. Instructor in Civil Engineering, Polytechnic Institute, Brooklyn, N. Y.....	Jan.	14, 1909
LLEWELLYN, FRED. T. With Carnegie Steel Co., 30 Church St., New York City.....	Feb.	10, 1910
LOBO, CARLOS. Asst. Engineer, Dept. Water Supply, Gas and Electricity, 13-21 Park Row, New York City...	May	10, 1906
LOCKE, J. CALVIN. Assistant Engineer, Topographical Bureau, 1880 W. 7th St., Brooklyn, N. Y.....	Nov.	6, 1896
LOCKWOOD, HOWARD T. 929 East 22d St., Brooklyn, N. Y.	April	9, 1908
LONG, E. McLEAN. Civil Engineer, 172 Fulton St., N. Y.	Oct.	13, 1904
LUTZ, ULYSSES S. 280 Broadway, N. Y.....	Oct.	8, 1908
MACON, WILLIAM W. Engineering Editor, <i>The Iron Age</i> , 239 West 39th St., N. Y.....	Feb.	9, 1905
MALTBY, EDWARD L. 50 Church St., Room 671, N. Y...	Oct.	9, 1896
MARKEY, WILLIAM A. Assistant Engr., Bureau of Sewers, 1618 Beverley Road, Brooklyn, N. Y.....	June	24, 1897
MARTIN, CHARLES B. 17 North Parsons Ave., Flushing, N. Y.	May	6, 1897
MARTIN, KINGSLEY L. President, The Foundation Co., 115 Broadway, N. Y.	Jan.	7, 1897
MCCOLL, ERNEST N. Transitman, Bureau of Highways, Room 36 Municipal Bldg., Brooklyn, N. Y.....	Jan.	8, 1903

	Date of Election.	
McGRONAN, CHAS. J. Asst. Engineer, Board of Water Supply, 451 East 170th St., N. Y.....	April	11, 1912
McINENLY, CHAS. W. Asst. Engr., Public Service Commission, 154 Nassau St., Room 1812, N. Y. City....	Jan.	10, 1907
McKAY, JOHN W. Borough Hall, St. George, S. I., N. Y.	Feb.	13, 1908
McLAUGHLIN, WILLIAM E. Draftsman, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	Oct.	14, 1909
MEAD, JOHN F. Room 2003 Park Row Bldg, N. Y. City..	Feb.	8, 1906
MEADS, CHARLES. President, Charles Meads & Co., Contractors, 299 Broadway, N. Y.....	Nov.	10, 1904
MEEM, JAMES COWAN. Engineer, with Frederick L. Cranford, 177 Montague St., Brooklyn, N. Y.....	Oct.	9, 1896
MESEROLE, WALTER M. Commissioner and Gen. Supt., Atlantic Ave. Improvement, 44 Court St., Brooklyn, N. Y.	Oct.	9, 1896
MESSENGER, WILLIAM H. Asst. Engr., Bureau of Highways, 1061 Bergen St., Brooklyn, N. Y.....	Oct.	12, 1905
MIDDLETON, JOHN. Civil Engineer and City Surveyor, 2511-2513 Atlantic Ave., Brooklyn, N. Y.....	Jan.	7, 1897
MILLER, EDWIN L. Civil Engr. and City Surveyor, 31 Ocean Parkway, Brooklyn, N. Y.....	Jan.	13, 1910
MOHN, WALTER L. 477 Bainbridge St., Brooklyn, N. Y..	Jan.	14, 1909
MORAN, HARRY P. Engineer, with Frederick L. Cranford, 177 Montague St., Brooklyn, N. Y.....	May	9, 1907
MORRIS, LARDNER V. Chief Engr., Bay Ridge and Jamaica Imp., L. I. R. R. Co., 1964 Broadway, Brooklyn, N. Y.	April	12, 1906
MORRIS, WM. HARLEY. With Hennebique Construction Co., 328 Putnam Ave., Brooklyn, N. Y.	April	11, 1912
MOSSCROP, WILLIAM A. Mechanical Engineer, 812 Prospect Pl., Brooklyn, N. Y.....	Jan.	10, 1901
MURPHY, FRANCIS P. City Surveyor and Civil Engineer, 177 Montague St., Brooklyn, N. Y.....	Oct.	13, 1910
NAGEL, JOHN. Civil Engineer, Manhattan Beach, N. Y.	May	11, 1911
NELSON, JAMES W. Manager, Richard Dudgeon, 82 Broome St., N. Y.	May	12, 1904
NEXSEN, RANDOLPH H. Asst. Electrical Engr., Public Service Commission, Box 1959, New York City....		
NOBLE, FREDERICK C. Div. Engr., P. S. C., 1st Dist., 23 Flatbush Ave., Brooklyn, N. Y.....	Mar.	9, 1905
	April	14, 1910

	Date of Election.	
NOSWORTHY, ARTHUR. Vice-Pres. and Genl. Mgr., Seaboard Construction Co., 375 Fulton St., Brooklyn, N. Y.	Jan.	12, 1905
NOWACZEK, FRANK O. Dept. of Taxes and Assessments, Brooklyn, N. Y.	Nov.	6, 1896
OAKES, FRANK J. Mechanical Engineer, with Henry R. Worthington, Hotel St. George, Brooklyn, N. Y....	May	6, 1897
OESTREICH, HENRY L. Sen. Asst. Div. Engineer, Public Service Commission, 429 16th St., Brooklyn, N. Y.	Mar.	10, 1910
O'CONNOR, THOMAS. Civil Engineer, 667 Vanderbilt Ave., Brooklyn, N. Y.....	Jan.	12, 1905
ORROK, GEO. A. Mechanical Engineer, New York Edison Co., 55 Duane St., New York City.	Nov.	10, 1904
*OULD, JOHN G. Supt., Polhemus Memorial Clinic, Henry and Amity Sts., Brooklyn, N. Y.....	Feb.	8, 1900
PAGE, RAYMOND. City Surveyor, 177 Montague St., Brooklyn, N. Y.	Mar.	12, 1908
PARFITT, WALTER E. Architect, 26 Court St., Brooklyn, N. Y.	Mar.	9, 1905
PERRY, ARTHUR IRVING. Assistant Engineer, Dept. of Bridges, Park Row Bldg., N. Y.....	Nov.	6, 1896
PERRY, FRANCIS W. Asst. Engr., Dept. of Bridges, 214 Parkside Ave., Brooklyn, N. Y.	Oct.	12, 1899
PERRY, FRANK J. 378 St. Johns Pl., Brooklyn, N. Y...	Feb.	8, 1906
PINCO, CHAS. N. Assistant Engineer, Dept. of Bridges, 142 East 74th St., New York City.....	Jan.	10, 1907
POLLOCK, CLARENCE D. Engineer, in charge of Paving, Calle Cuba 24, Havana, Cuba.....	Oct.	9, 1896
PROVOST, ANDREW J., JR. Consulting Engineer, 39 West 38th St., New York City	Oct.	9, 1896
PURDY, WALTER M. 524 Lafayette Ave., Brooklyn, N. Y.	Jan.	10, 1907
QUICK, HOWARD P. Mechanical Engineer, 314 Eighth Ave., Brooklyn, N. Y.....	May	13, 1909
REBHANN, JOSEPH H. B. Concrete Machinery, 1148 Dean St., Brooklyn, N. Y.....	May	11, 1911
REIFSNYDER, HARLAND B. Assistant Engineer, Dept. of Bridges, Park Row Bldg., New York City.....	Jan.	11, 1906
RELIHAN, EDWARD J. Transitman, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	Jan.	14, 1909

*Died December 21, 1911.

	Date of Election.	
RIEDEL, JOHN C. Assistant Engineer, Bureau of Sewers, Brooklyn, Mechanics Bank Bldg., Brooklyn, N. Y...	Jan.	9, 1902
ROBERTS, WINFRED H. Assistant Engineer, Dept. Finance, 55 Stewart Bldg., Manhattan, 4614 11th Ave., Brooklyn, N. Y.	April	13, 1899
ROCKWOOD, NATHAN C. Asst. Editor, <i>Engineering News</i> , 505 Pearl St., New York City.....	Nov.	10, 1910
ROGERS, JOHN R. 251 Gates Ave., Brooklyn, N. Y.....	Oct.	11, 1906
ROSA, PAUL. 236 So. 9th St., Brooklyn, N. Y.....	May	11, 1911
RUSSELL, RICHARD LORD. Chief Engr. and Supt. for Chas. Cranford, Genl. Contractor, 868 Delamere Pl., Brooklyn, N. Y.	Oct.	12, 1905
RYAN, JOSEPH A. 41 Municipal Bldg., Brooklyn, N. Y.	Feb.	9, 1905
SAB VANT, WILBUR N. 16 Verona Pl., Brooklyn, N. Y...	Oct.	14, 1909
SCHERMERHORN, RICHARD, JR. Landscape Architect and Engineer, 347 Fifth Ave., New York City.....	Jan.	12, 1899
SCHMIDT, HERMAN H. Chief Engineer, Bureau of High- ways, 12 Municipal Bldg., Brooklyn, N. Y.....	May	10, 1904
SCHMITT, JACOB. 36 South Oxford St., Brooklyn, N. Y..	Feb.	11, 1904
SCHWEITZER, GEORGE J. Assistant Engineer, Topo- graphical Bureau, 209 Montague St., Brooklyn, N. Y.	Mar.	10, 1904
SEAMAN, HENRY B. Consulting Engineer, 165 Broadway, New York City	Jan.	6, 1898
SHALER, E. CONWAY. Asst. Engr., Track Dept., B. R. T. System, 85 Clinton St., Brooklyn, N. Y.....	April	14, 1898
SHEA, WILLIAM J. 980 St. Johns Pl., Brooklyn, N. Y..	Jan.	14, 1909
SHEFFIELD, ARTHUR W. Superintendent, Pell & Corbett, Architects, 31 Union Sq., N. Y.....	Jan.	12, 1905
SHERIDAN, JOHN C. Chief Engr., Cranford Co., 52 9th St., Brooklyn, N. Y.....	Jan.	10, 1901
SIMMONS, EDWARD A. President, <i>Railway Age Gazette</i> , 83 Fulton St., New York City.....	Oct.	14, 1909
SINCLAIR, HENRY A. Secretary, Treasurer & Electrical Engineer, Tucker Electrical Construction Co., 110 West 30th St., New York City.....	Nov.	11, 1909
SKINNER, FRANK W., Assoc. Editor, " <i>Engineering Rec- ord</i> ," 41 Sherman Ave., Tompkinsville, N. Y.....	May	9, 1912
SLIPPER, CHARLES J. 117 Remsen St., Brooklyn, N. Y.	Jan.	10, 1901
SLOAN, FRANK T. 103 Berkeley Pl., Brooklyn, N. Y....	Oct.	11, 1906

	Date of Election.	
SMITH, JESSE E. Draftsman, Board of Education, Brooklyn, N. Y.	April	8, 1909
SMITH, HARTLEY L. H. 582 Bedford Ave., Brooklyn, N. Y.	Nov.	10, 1910
SNELL, HARRY B. With Million Bros. Co., 34 West 33d St., N. Y.	Nov.	9, 1905
SNYDER, CHESTER A. Architect, Northern Contracting Co., N. Y., 7 Spencer Pl., Brooklyn, N. Y.	Feb.	8, 1912
SOMNER, CLEMENT A. 4614 11th Ave., Brooklyn, N. Y..	Jan.	11, 1906
SPEAR, WALTER E. Dept. Engineer, Board of Water Supply, 250 West 54th St., N. Y. City.	May	13, 1909
SPRONG, SEVERN D. Electrical Engineer, Edison Electric Ill. Co., 360 Pearl St., Brooklyn, N. Y.	Mar.	8, 1906
STANGLE, WM. H. Architect, 25 Broad St., N. Y.	Nov.	9, 1911
STANLEY, NATHAN W. Assistant Engineer, Topographi- cal Bureau, 209 Montague St., Brooklyn, N. Y.	Jan.	14, 1909
STEIN, JOHN B. Assistant Engineer, Topographical Bureau, 917 Avenue N, Brooklyn, N. Y.	Jan.	8, 1903
STEINMETZ, JOHN M. 606 East 84th St., N. Y.	Mar.	9, 1905
STILES, LINFORD S. Construction Engineer, Brooklyn Union Gas Co., 1241 Carroll St., Brooklyn, N. Y.	Jan.	11, 1912
STOREY, FRANKLIN S. Superintendent, Phoenix Construc- tion Co., 41 Park Row, N. Y.	Mar.	9, 1905
STOWE, HAROLD C. President, H. C. Stowe Construction Co., 172 So. Oxford St., Brooklyn, N. Y.	Oct.	12, 1911
STRACHAN, JOSEPH. Secretary, Brooklyn Engineers' Club, 117 Remsen St., Brooklyn, N. Y.	Oct.	9, 1896
STRACHAN, ROBERT C. Assistant Engineer, Dept. of Bridges, Park Row Bldg., New York City.	Jan.	12, 1899
STRONG, MARVIN W. 720 Ditmas Ave., Brooklyn, N. Y..	Oct.	11, 1906
TAYLOR, GRANT S. Assistant Engineer, 117 Remsen St., Brooklyn, N. Y.	Mar.	11, 1909
TENNEY, WILLIS R. Assistant Engineer, Bureau of Highways, Municipal Bldg., Brooklyn, N. Y.	Jan.	7, 1897
THOMASON, LOUIS S. With M. W. Kellogg Co., 50 Church St., New York City.	April	14, 1910
TILLSON, GEORGE W. Consulting Engineer to the Bor- ough President, Brooklyn, N. Y.	Oct.	9, 1896
TURNER, HENRY C. Pres., Turner Construction Co., 11 Broadway, New York City	April	12, 1906

	Date of Election.	
TUTTLE, ARTHUR S. Engineer in charge, Division of Public Improvements, Board of Estimate and Apportionment, 277 Broadway, New York City.....	Oct.	9, 1896
VAN BUSSUM, JOHN D. Asst. Engr., Dept. of Finance, 280 Broadway, N. Y.	May	8, 1902
VAN NORDEN, ERNEST M. Civil Engineer, New York Edison Co., 55 Duane St., N. Y.....	Mar.	10, 1904
VIOLA, BARTHOLOMEW. 11 Bartlett St., Brooklyn, N. Y..	May	12, 1910
WARD, CHARLES R. Chief Engineer, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	April	13, 1905
WATHEY, JOHN W. American Concrete Steel Co., Newark, N. J.	Nov.	8, 1906
WEIDERMAN, GEORGE. Pres., Geo. Weiderman Electric Co., 191 Flatbush Ave., Brooklyn, and 35-37 Rose St., N. Y.....	Assoc. Nov.	9, 1899
	Corp. April	11, 1912
WELLS, WALTER F. 360 Pearl St., Brooklyn, N. Y.....	Jan.	11, 1906
WHEELER, HARRY R. Chief Engineer & Secretary, of Henry Steers, Inc., New York City.....	Oct.	14, 1909
WHIPPLE, GEORGE C. Professor of Sanitary Engineering, Harvard University; Consulting Engineer, 103 Park Ave., N. Y.	Oct.	13, 1898
WHIPPLE, MELVILLE C. Chemist, 85 Livingston St., Brooklyn, N. Y.	April	9, 1908
WHITE, E. SHERMAN. Engineer in charge, Bureau of Public Buildings and Offices, Brooklyn, N. Y.....	Nov.	6, 1896
WHITE, GEORGE L. Transitman, Topographical Bureau, 209 Montague St., Brooklyn, N. Y.....	Oct.	14, 1909
WHITNEY, CHAS. A. 138 State St., Brooklyn, N. Y.....	Nov.	12, 1908
WILCOCK, FREDERICK. Asst. Engr., Public Service Commission, 23 Flatbush Ave., Brooklyn, N. Y.....	Jan.	11, 1906
WILDER, CLIFTON W. Elec. Engr., P. S. C., 406 E. 21st St., Brooklyn, N. Y.	April	9, 1908
WILLIAMS, RICHARD L. Civil Engineer and City Surveyor, 189 Montague St., Brooklyn, N. Y.....	Nov.	6, 1896
WILSON, THAD L. Assistant Engineer, Public Service Comm., 1532 Bedford Ave., Brooklyn, N. Y.....	Feb.	11, 1909
WINSLOW, GEORGE E. Assistant Engineer, D. P. W., 215 Montague St., Brooklyn, N. Y.....	Nov.	6, 1896
WOOD, NOBLE W. Hudson Engineering Co., 90 West St., N. Y.	May	6, 1897

	Date of Election.	
WOODCOCK, HENRY W. Civil Engineer and City Surveyor, 261 Fifty-second St., Brooklyn, N. Y.....	Mar.	9, 1905
WOODEN, HARRY S. Topographical Draftsman, Watershed Division, Dept. Water Supply, Gas & Electricity, Brooklyn, N. Y.	Oct.	14, 1909
WREAKS, HUGH T. Secty., Wire Inspection Bureau, 208 Fifth Ave., New York City.....	April	14, 1898
WYNKOOP, HUBERT S. Electrical Engineer, Dept. of Water Supply, Gas and Electricity, 13-21 Park Row, N. Y.	Feb.	4, 1897
YATES, WM. C. Engineering Dept., Gen'l. Elec. Co., 30 Church St., New York City.	May	12, 1910
ZARTMANN, WILLIAM J. Superintendent of Parks, Brooklyn & Queens; 1908 Ave. K, Brooklyn, N. Y.....	Mar.	11, 1909

ASSOCIATE MEMBERS.

ANGELL, CHARLES A. Vice-Pres., Cranford Company, 52 9th St., Brooklyn, N. Y.....	April	12, 1900
BAILLIE, ELLIS H. Sec., The Wilson Baillie Mfg. Co.; Pres., Kosmos Engr. Co., 26 Court St., Brooklyn, N. Y.	June	24, 1897
BURR, JOHN W. General Manager, Burr and Houston Co., 84 Calyer St., Brooklyn, N. Y.....	Feb.	13, 1902
CRANFORD, CHARLES. Boston Development and Sanitary Co., Old South Building, Boston, Mass.....	Mar.	8, 1906
CRANFORD, WALTER V. President, Cranford Company, 190 Montague St., Brooklyn, N. Y.....	April	14, 1898
CRONIN, BARTH S. General Contractor, 282 President St., Brooklyn, N. Y.	Mar.	9, 1911
CUOZZO, DONATO. General Contractor and Expert in Concrete Work, 13-23 Park Row Bldg., N. Y.....	Jan.	12, 1905
DAYBILL, ALFRED. President, Miller, Daybill & Co., Inc., 34 W. 33d St., New York City.....	Mar.	8, 1906
GRINDEN, WILLIAM J., President, Grinden Art Metal Co., Marcy Ave. & Walton St., Brooklyn, N. Y.....	June	24, 1897
HARDEN, JAS. H. Grand St. and Morgan Ave., Brooklyn, N. Y.	Oct.	13, 1910
HIGGINSON, WILLIAM. 407 Hancock St., Brooklyn, N. Y.	May	14, 1908
HUBBARD, EDW. L. 164 Maple St., Brooklyn, N. Y....	Oct.	13, 1910

	Date of Election.	
JEWELL, HARRY A. Ball & Jewell, 26 Franklin St., Brooklyn, N. Y.	Mar.	13, 1902
KEASBEY, ROBERT A. Contractor for Steam Pipe Covering, 100 North Moore St., N. Y.	Jan.	8, 1903
KILEY, THOMAS W. Thomas W. Kiley & Co., 57 Grand St., Brooklyn, N. Y.	June	19, 1902
MARTINO, JOHN S. 162 State St., Brooklyn, N. Y.	April	14, 1904
MONEYPENNY, NELSON N. Vice-President, Alberene Stone Co., 223 E. 23d St., N. Y.	Mar.	12, 1903
OGDEN, J. EDWARD. Iron and Steel Merchant, 747 Greene Ave., Brooklyn, N. Y.	Nov.	12, 1903
ORMOND, WILLIAM C. Plumbing Contractor, 909 President St., Brooklyn, N. Y.	Oct.	12, 1905
O'SHEA, G. HARRY. 29 Broadway, N. Y.	May	10, 1906
SCANLON, JOHN F. Inspector, Engineer's Bureau, Dept. of Finance; 667 Lafayette Ave., Brooklyn, N. Y. ...	Oct.	13, 1904
SHINN, EUGENE. 1081 East 19th St., Brooklyn, N. Y. ...	Oct.	8, 1908
SIMMONS, JOHN S. Vice-President, John Simmons Co., 104-110 Centre St., New York.	Nov.	13, 1902
STAGG, JOHN P. Chief Clerk, Brooklyn Union Gas Company.	Jan.	14, 1909
WANDELL, WILLIAM S. Lumber Dealer, firm of Hardy, Voorhees & Co., Metropolitan Ave. and Newtown Creek, Brooklyn, N. Y.	June	19, 1902
WILLIAMS, LOUIS W. 1512 Bedford Ave., Brooklyn, N. Y.	Oct.	8, 1908

NON-RESIDENT MEMBERS.

BALL, LAURENCE A. Structural Engineer, 127 N. Walnut St., East Orange, N. J.	Mar.	14, 1907
BLOSSOM, FRANCIS. Partner; Sanderson & Porter, 52 William St., N. Y.	Nov.	6, 1896
CARMALT, LAURANCE J. Asst. Engineer, with N. Y., N. H. & H. R. R. Co., Cos Cob, N. Y.	May	8, 1902
CARPENTER, TOWNSEND. Care of Eisenwein & Johnson, 781 Ellicott Sq., Buffalo, N. Y.	Oct.	14, 1909
CHASE, RICHARD D. 59 Fourth St., New Bedford, Mass.	Jan.	7, 1897
CILLEY, MORGAN. In care 1524 76th St., Brooklyn, N. Y.	Oct.	11, 1906
CONN, CHAS. F. Engr., J. G. White & Co., Inc., Alaska Commercial Bldg., San Francisco, Cal.	Jan.	10, 1901
COWPERTHWAIT, ALLAN. Hydewood Park, Plainfield, N. J.	Nov.	9, 1899

	Date of Election.	
CUDWORTH, FRANK GRANT. Engineer and Architect, Cudworth, Axtell & Co., Engineers, 601 Kansas City Life Bldg., Kansas City, Mo.	Feb.	4, 1897
DURYEA, EDWIN, JR. Consulting Engineer, Duryea, Haehl & Gilman, 1314 Humboldt Bank Bldg., San Francisco, Cal.	Oct.	13, 1898
EKSTRAND, CHAS. Mechanical and Electrical Engineer, "The Park," Boonton, N. J.	Mar.	14, 1901
FAST, GUSTAV. Consulting Engineer, Orange, N. J.	May	11, 1911
GUNTHER, C. GODFREY. Tucson, Ariz.	April	12, 1906
GUTHRIE, KEITH O. Waterford, N. Y.	Oct.	10, 1901
HAMMER, JOHANNES M. Care of McClintic-Marshall Const. Co., Braddock, Pa.	Oct.	11, 1906
HAWKHURST, HAROLD E. Civil Engineer and Surveyor, Westbury, L. I.	Jan.	14, 1909
HELLER, JOHN W. Engineering Contractor, 738 Broad St., Newark, N. J.	May	11, 1905
HEVENOR, HERMAN P. 344 Edgewood Ave., New Haven, Conn.	Jan.	14, 1909
HOUSTON, ROBT. R. 347 Fifth Ave., New York City.	Mar.	12, 1908
KENNEDY, MATTHEW E. Secretary, The Kennedy Valve Mfg. Co., Elmira, N. Y.	Feb.	9, 1905
KNIGHT, FRANK B. Chicago Manager and Engineer, Lidgerwood Mfg. Co., 1917 Fisher Bldg., Chicago, Ill.	May	10, 1906
LEGARE, BALIE PEYTON. Chief Engineer, United Rail- roads of San Francisco, Cal.	April	14, 1898
MORRELL, ALFRED M. Spicer Universal Joint Mfg. Co., Plainfield, N. J.	Mar.	14, 1907
PACKE, EDWARD H. Metropolitan St. R. R. Co. Kansas City, Mo.	Jan.	7, 1897
PHILBRICK, JOSEPH. Mechanical Engineer with Towle Mfg. Co., Newburyport, Mass.	Mar.	11, 1909
ROWELL, GEORGE F. Resident Engineer, Chattanooga & Tennessee River Power Co., Guild, Marion Co., Tenn.	Nov.	6, 1896
RUBY, ERNEST L. 46 South 8th St., Richmond, Ind.	Oct.	14, 1909
SANBORN, JAMES F. Asst. Engineer, Board of Water Supply, Stone Ridge, N. Y.	Jan.	12, 1905
SHAYER, GEO. F. Vice-Pres. and Engineer of the Pyrene Mfg. Co. of N. Y., Sayville, L. I.	Oct.	12, 1911

	Date of Election.	
SKEHAN, EUGENE A. Electrical Draftsman, N. Y. Edison Co., 220 East Ridgewood Ave., Ridgewood, N. J.	Oct.	14, 1909
SPOFFORD, CHARLES M. Hayward Professor of Civil Engineering, Mass. Institute of Technology, Boston. Mass.	Nov.	9, 1905
STONE, ARTHUR W., Bedford, Ind.	Jan.	9, 1908
THOMSON, SAMUEL F. Asst. Engr., Board of Water Supply, New Paltz, Ulster Co., N. Y.	Feb.	11, 1904
TUTTLE, WILLARD S. 1150 Evergreen Ave., Plainfield, N. J.	May	6, 1897
VAIL, FREDERICK N. Civil Engineer, Alliance Bldg., Stockton, Cal.	Jan.	7, 1897
VAN VLECK, JAMES B. 5831 Clemens Ave., St. Louis, Mo.	April	13, 1905
WHITTALL, WM. VAN R. Trull Hall, Plainfield, N. J.	Oct.	13, 1910
WOLCOTT, C. STANTON. Care of Y. M. C. A., Hazleton, Pa.	May	11, 1905

PROCEEDINGS OF THE FIFTEENTH ANNUAL MEETING OF THE BROOKLYN ENGINEERS' CLUB.

The meeting was called to order at the Hamilton Club, on Thursday evening, December 14th, 1911, at 9 o'clock, immediately following the annual dinner, held at that place; President Winfred H. Roberts presiding; Joseph Strachan, Secretary, and one hundred and ten members and guests being present.

Upon motion, duly carried, the reading of the minutes of the meeting of November 9 was omitted.

The Club was addressed by Hon. Chas. A. Towne, former U. S. Senator from Minnesota, upon "A Mechanical Equivalent of Consciousness." The Hon. Raymond B. Fosdick, Commissioner of Accounts for the City of New York, spoke of "Scientific Management and Municipal Government," and Hon. Lewis H. Pounds, Commissioner of Public Works of the Borough of Brooklyn, followed, his theme being "The Municipal Engineer and the City Government."

All of the speaking was listened to with marked attention and was greatly enjoyed by the Club members and their guests.

This being the Annual Meeting of the Club, the Report of the Board of Directors to the Club, describing the work done and the progress made during the year 1911, was read by the Secretary.

To the Members of the

BROOKLYN ENGINEERS' CLUB.

Gentlemen: In accordance with the requirements of the Constitution, the Board of Directors of the Brooklyn Engineers' Club presents herewith its Annual Report.

The year has been an exceedingly busy one, as is shown by the following list of papers and informal talks given and social functions held since January 1st, 1911:

January 6th, 1911.—Smoker at the clubhouse.

January 12th.—Regular meeting. Paper No. 100.

January 19th.—Informal talk, "The Lubrication of Cylinders," by Mr. R. C. Garhart.

January 26th.—Informal talk, "Steam Flow Meters," by Mr. A. L. Johnston.

February 2d.—Ladies' night. Lecture, "The Panama Canal," by Mr. Chas. W. Baker.

February 9th.—Regular meeting. Paper No. 101.

February 16th.—Informal talk "Modern Design of Centrifugal Pumps," by Mr. Gustav Fast.

February 23d.—Informal talk, "The Costa Rica Earthquake and Its Effect Upon Various Classes of Buildings," by Prof. Chas. M. Spofford.

March 2d.—Informal talk, "Modern Printing Press Control," by Mr. W. C. Yates.

March 9th.—Regular meeting. Paper No. 102.

March 11th.—Visit to Philadelphia Engineers' Club.

March 16.—Informal talk, "High-Speed Steel," by Mr. Wm. A. Du Bois.

March 23d.—Informal talk, "Up-to-Date Conveyor Installations," by Mr. C. Kemble Baldwin.

March 25th.—Annual smoker.

March 30th.—Informal talk, "Tests for Building Department on Traps and Ventilation," by Mr. A. E. Hanson.

April 6th.—Informal talk, "Steam Turbines," by Mr. H. H. Barnes, Jr.

April 13th.—Regular meeting. Paper No. 103.

April 18th.—Engineering exhibition.

April 19th.—Engineering exhibition.

April 20th.—Engineering exhibition.

April 21st.—Engineering exhibition.

April 22d.—Engineering exhibition.

April 27th.—Informal talk, "Rust Prevention," by Prof. A. H. Sabin.

April 29th.—Concert.

May 4th.—Informal talk, "Bridge Building in the Hawaiian Islands," by Mr. John W. Hamilton.

May 6th.—Excursion, Fourth Avenue Subway.

May 11th.—Regular meeting. Paper No. 104, followed by concert of the Polytechnic Glee, Banjo and Mandolin Clubs.

May 13th.—Excursion, H. F. Krautz Electrical Manufacturing Company.

May 18th.—Ladies' night. Lecture, "Items from the Orient," by Mr. Louis L. Tribus.

May 25th.—Informal talk, "Steam Railroad Electrification," by Mr. Frederick Darlington.

June 17th.—Excursion, Perth Amboy.

June 22d.—Ladies' dinner at Brighton Beach.

October 12th.—Regular meeting. Paper No. 105.

October 19th.—Informal talk, "History and Description of the Westinghouse Air Brake," by Mr. W. G. Kaylor.

October 21st.—Smoker in clubhouse.

- October 26th.—Informal talk, "Chasing the Firebug," by Mr. W. L. Beers.
- November 2d.—Informal talk, "The United States Army Camp in Texas," by Capt. Robert S. Allyn.
- November 4th.—Excursion, Bay Ridge Improvement.
- November 9th.—Regular meeting. Paper No. 106.
- November 16.—Ladies' night, "The Parker Expedition to Mount McKinley," by Mr. Waldemar H. Grassi.
- November 23d.—Informal talk, "Design and Manufacture of Spur Gearing," by Mr. Ralph E. Flanders.
- November 27th.—Reception by the Board of Directors.
- December 7th.—Informal talk, "Water Meters," by Col. John A. Drew.
- December 14th.—Annual Dinner.

The House Committee.—Early in the year the House Committee associated with itself the following Auxiliary Committee: Messrs. Lewis P. Brown, Wm. J. Conway, John H. Duncan, C. R. Gabriel, Clyde D. Gray, Geo. H. Hughes, Frederick Ljung, Edwin L. Miller, Francis P. Murphy, Walter L. Mohn, H. B. Reifsnnyder, Nathan C. Rockwood, Hartley L. H. Smith, L. S. Thomason, Bartholomew Viola, Wm. C. Yates and W. M. Purdy.

The first event held by the House Committee was an informal smoker in the clubhouse. The entertainment was furnished by the members and their friends, and the only expense to the Club was for refreshments and accompanist. Attendance, 110.

Musical numbers and monologues were given by Messrs. Mohn, Conlon, Head, Frank, Hough, Pinco, Agramonte, Gabriel, Collins and Byrnes.

The fifth annual concert and smoker was held at the Kings County Palace on March 25th, 1911. Attendance, 510.

As in the past, the entertainment was given entirely by members of the Club and friends. Part one of the program consisted of four instrumental selections given by thirty members of the Amicitia Orchestra, of Jersey City. Part two consisted of eleven numbers given by a chorus of twenty-five members of the Bay Ridge Athletic Club, under the management of Mr. Frank L. Martin, with songs, monologues, etc., by Messrs. Collins, Forsman, Wilkes, May, Ring, Wilson, Armour, Corbett, Self and Hoyt.

The concert given in the clubhouse on April 29th, 1911, was most artistic. Attendance, 125. Selections rendered by The Von Ende Violin Choir of twenty violins, piano and organ, under the leadership of Mr. Herwegh Von Ende, and the solo numbers by Mme. Boriska De Ujfalusy, soprano; Master Harold Muckline, violin, and Mr. Sigmund M. Bassell, piano, were greatly enjoyed by the members and the ladies of their families.

The program on this occasion was unusually artistic, the cover being decorated with three interior views of the clubhouse. This concert was arranged by Mr. Bartholomew Viola, member of the Auxiliary House Committee.

After the regular business meeting and paper of May 11th, 1911, the Glee, Banjo and Mandolin Clubs of the Polytechnic Institute, under the leadership of Mr. G. Warren Stebbins, gave a vocal and instrumental concert of eight numbers, which was greatly enjoyed. The arrangements for this neighborly visit were made by Mr. J. J. Johnson, member of the Brooklyn Engineers' Club and of the Polytechnic Glee Club.

The fourteenth annual dinner to the ladies was given at the Hotel Jefferson, Brighton Beach on Thursday, June 22d, 1911. An innovation on this occasion was a response to a toast by a lady, Miss Harriet Mae Mills, President of the New York State Women's Suffrage Association. Interesting addresses were also made by Hon. Edward M. Bassett and Rev. Lewis T. Reed, and excellent solos were given by Messrs. Peter J. Collins and Albert J. Wiederhold.

On Saturday evening, October 21st, 1911, a smoker was held in the clubhouse. Attendance, 100.

For this occasion Mr. E. H. Blunt, of the Club, organized and trained a glee club of eighteen and an orchestra of eleven members and friends. The choruses and orchestral selections were rendered in a creditable manner, and solos were given during the evening by Messrs. Hicks, Conners, Conlon, Fitzpatrick and Stepan.

The reception given by the Board of Directors to the members and ladies was a pleasant affair. During the evening solos were sung by Messrs. Conners and Conlon, refreshments were served and the company danced until midnight.

Arrangements for the annual dinner at the Hamilton Club on December 14th, 1911, are complete. The speakers are Hon. Chas. A. Towne, ex-Senator from Minnesota; Hon. Lewis H. Pounds, Commissioner of Public Works, Brooklyn, and Hon. Raymond B. Fosdick, Commissioner of Accounts, New York City.

The House Committee has done good work in renting rooms in the house, looking after repairs to the house, including the construction of a new portable stage in the meeting room, arranging for refreshments after regular meetings and assisting other committees, notably during "exhibition week."

The Library Committee.—As the income of the Club is limited it was decided to purchase for the library only such books as were known to be needed. A notice was therefore sent to the members that all appropriations

had been made for the purchase of technical books, and that any book for which a request was made would be purchased. A notice was also posted in the library asking members to file a memorandum for the Library Committee of any book looked for in the library but not found.

With the addition of books given to the Club, the new library started after the purchase of the house now numbers 284 volumes, not including a very much larger number of reports, transactions, etc..

Seventy-seven volumes of the current engineering publications subscribed for by the Club have been bound and placed in the library this year.

The Library Committee has also produced an excellent set of plans for the future enlargement of the clubhouse, and has drawn plans for, and with the co-operation of the House Committee supervised the installation of a new steam-heating plant in the present house, which is a very valuable improvement.

Committee on New Membership.—The Club shows a gain in membership as the result of the year's work.

There have been elected 17 Corporate, 2 Associate and 2 Non-Resident Members with four applications received but not acted upon.

The Entertainment Committee.—As the result of the earnest and successful work of this Committee papers of high quality have been presented at every regular and informal meeting throughout the year.

It should be noted that this year members have been commendably prompt in delivering their finished papers for publication, all of the papers presented during the year, with the exception of that presented at the last meeting, being now in the hands of the Secretary, ready for publication.

Members have been invited to bring the ladies of their families to three of the informal library evenings this year, the topics presented being as follows: February 2d, 1911, "The Panama Canal"; May 18th, 1911, "Items from the Orient"; November 16th, 1911, "The Parker Expedition to Mount McKinley."

The attendance at these meetings has been from 80 to 95, indicating that this is a feature of the Club life which should be continued.

The Committee has arranged for the regular paper to be given in January and for all of the informal library talks up to the first regular meeting of February.

The Excursion Committee.—Five excursions have been held during the year.

On Saturday, March 11th, 1911, a social call was made on the Philadelphia Engineers' Club. A special car left Flatbush Avenue Station of the Long Island Railroad at 2:15 P. M., and the Pennsylvania Station in Manhattan at 3 P. M., arriving in Philadelphia at 5 o'clock. The party of

thirty-five was met at the Broad Street Station by a delegation from the Philadelphia Club and escorted to the clubhouse. The banquet given by the Philadelphians overtaxed the capacity of the dining hall. After some toasts and speeches the party adjourned to the cafe in the basement of the clubhouse, where a smoker and fine vaudeville performance was given. The special car returned with the 10:30 train from Philadelphia, a large number of the Philadelphians escorting our party to the train.

The Chairman of the Committee deserves great credit for the efficient manner in which he handled this excursion.

It is unfortunate that the Philadelphia Engineers' Club was forced to cancel, at the last moment, the arrangement it made for its return visit in June.

On Saturday, May 6th, 1911, an inspection was made of the Fourth Avenue Subway from 15th to 36th Streets.

This party was under the management of Mr. H. L. Oestreich, Division Engineer, Public Service Commission, and member of the Club.

The steel forms for concrete used by the Tidewater Construction Company and many other interesting details of subway construction were observed.

On Saturday, May 11th, 1911, a visit was made to the factory of Mr. Hubert F. Krantz, Member of the Brooklyn Engineers' Club. A portion of the factory was kept in operation so that members could see the method of marbleizing slate, porcelain enameling on steel and other details of the manufacture of electric switchboards and specialties.

On Saturday, June 17th, 1911, through Mr. P. H. Bevier, Chief Engineer of the National Fireproofing Company and a former Member of the Club, a very enjoyable excursion was made to the works of the National Fireproofing Company at Perth Amboy, N. J.

The company's tug "Fireproof" left Pier 15, near the Battery, at 12:30 P. M., taking the party on a three-hour sail around the west side of Staten Island. An elaborate lunch was provided for the guests. All of the different processes in the manufacture of terra cotta building blocks were observed. The visit was very interesting and instructive, and we were fortunate in having weather exactly suited to the occasion.

On Saturday, November 4th, 1911, a trip was made over the work of the Bay Ridge Improvement. A special train, containing a day coach and a buffet observation car, left East New York Station of the Long Island Railroad at 2 P. M., proceeding to 65th Street and 1st Avenue, thence back to the Brighton Beach Railroad and to Manhattan Beach; thence to the Sunnyside Yard at Long Island City; thence to Jamaica and back to East New York, arriving at 5:30 P. M. The thanks of the Club are due

to the President of the Long Island Railroad for his courtesy in this matter and to Mr. Lardner V. Morris, Chief Engineer of the Bay Ridge Improvement and Member of this Club, for arranging the excursion.

Press Committee.—This special Committee, appointed this year for the first time, was created to further the interests of the Club by bringing its activities and advantages before the public through the daily papers.

The Committee began its work by the purchase of a scrap book in which to keep newspaper clippings, programs, etc. It is believed that this scrap book record, kept in the library, will be of increasing interest as years go by.

The remarkable results of the system finally perfected by the Committee is indicated by the fact that over 3 400 lines of reading matter, in addition to a half-page special article, were devoted to the Club's affairs by the newspapers of the city during the months of October and November alone.

Publication Committee.—The *Proceedings* for last year was published, and is fully up to any of its predecessors in appearance and quality. In connection with his work of obtaining advertisements the Business Manager organized one of the most successful innovations of the year, namely:

The Exhibition.—For five days and evenings, April 18th to 22d, inclusive, the clubhouse was thrown open to the public with an exhibition of models of machinery used in engineering work, etc.

Thirty firms and individuals exhibited. The attendance was good, and the exhibition was favorably commented upon by the daily press and the engineering publications. A special Auxiliary Committee, consisting of Messrs. Grinden, Donnelly, Cuzzo, Sinclair, Wiederman and Simmons, assisted in this affair.

In connection with the publication should be noted the establishment of the Alfred T. White Prize.

This prize has been named after our only Honorary Member as a mark of our affection and respect. Its purpose is to stimulate the thorough preparation and prompt presentation for publication of technical papers by Members of the Club.

A committee consisting of Messrs. Arthur S. Tuttle, William W. Macon and J. S. Langthorn was appointed by the President to draw up rules governing the award of the prize, and a second committee, consisting of Messrs. James W. Nelson, Henry B. Seaman and Henry L. Oestreich, to report upon the kind of prize to be given.

The rules adopted have been sent to all Members with the notice of the annual meeting.

It was decided that the prize should be \$50 in cash and a certificate signed by the President, Secretary and Committee of Award. The Committee in charge has selected the design for the certificate, and it is expected

THIS IS TO CERTIFY THAT

The Franklin Engineering Club

has awarded the

Alfred C. Miller Prize

for the year

To

for a paper entitled

President

Secretary

Committee on Awards

that the certificate will be on exhibition at the annual dinner, December 14th, 1911.

Another event of interest during the year was the cancellation of debenture bonds of the Club to the amount of \$4 000. It was thought wiser to repay to members of the Club the amounts loaned by them to assist in the purchase of the house rather than to invest the surplus in securities which might have paid a slightly higher rate of interest than the club pays on the money it has borrowed.

The Club is to be congratulated upon its sustained progress during the year and upon the enthusiasm shown by the Members in their committee work.

The Secretary reports for the year the resignations of 11 Corporate and 2 Non-Resident Members, and 1 Corporate Member dropped for non-payment of dues, and regretfully adds the loss by death of Jno. J. McLaughlin, of whom a memoir and portrait will be placed in the *Proceedings* for 1911.

The membership is at present distributed as follows:

Corporate Members	286
Associate Members	32
Non-Resident Members	43
Honorary Member	1
<hr/>	
Total	362

The Auditing Committee.—In accordance with the Constitution this Committee has audited the books of the Secretary and of the Treasurer. The books have been found to be correctly kept, and a statement of receipts, expenditures, assets and liabilities of the Club is made a part of this report.

RECEIPTS.

Balance in Bank December 1, 1910.....	\$1 566.78
Dues and Initiations	3 852.20
Dinners, etc.	511.50
Mortgage, Principal and Interest	4 157.11
<i>Proceedings</i>	682.60
Rentals	1 286.32
Badges and Keys	41.00
Contribution to Library Fund	100.00
Members' Credits	27.50
Unpresented cheques	5.00
Bank Interest	79.73
<hr/>	
	\$12 309.74

EXPENDITURES.

Taxes—Real Estate	\$508.95	
Water	24.00	
Special	20.29	553.24
Redemption of Club Bonds.....		4 000.00
Interest on Club Bonds and Mortgage.....		1 390.33
Exchange on out-of-town cheques.....		1.20
Fuel		140.25
Lighting		240.86
Heating Plant		858.00
Miscellaneous Expenses		359.85
Repairs and Renewals		45.06
Salaries		1 351.50
Printing and Stationery		332.64
Postage		252.92
Typewriting and Stenography		176.60
<i>Proceedings</i> for 1910		906.96
Library		104.60
Dinners, etc.		778.38
Badges and Keys		29.50
Balance in Bank December 1, 1911.....		787.85
		<hr/> \$12 309.74

STATEMENT OF ASSETS AND LIABILITIES OF THE CLUB.

Assets.

House, 117 Remsen Street	\$29 000.00	
Furniture (cost value)	2 046.83	
Books, periodicals and <i>Proceedings</i> (back numbers) estimated	2 500.00	
Outstanding accounts—Dues, Rentals and Advertising	793.00	
Balance in Bank	787.85	
		<hr/> \$35 127.68

Liabilities.

Mortgage on House, 117 Remsen Street.....	\$18 000.00	
Bonds of the Club	6 000.00	
Outstanding accounts	500.00	
Excess of Assets over Liabilities.....	10 627.68	
		<hr/> \$35 127.68

The Board extends its thanks to the several committees for their work, the year has been a successful one, the Club is in a sound financial condi-

tion after having paid off a large portion of its indebtedness and after making many valuable improvements to its house. It has also continued the healthy growth it has had in the past and which we believe it will continue to enjoy in the future.

Respectfully submitted,

WINFRED H. ROBERTS
JOHN M. STEINMETZ
JOSEPH STRACHAN
WM. T. DONNELLY
HERBERT C. KEITH
WALTER F. WELLS
GEORGE A. ORBOK

The election of officers for 1912 was declared to be the next order of business, and by motion, duly carried, Mr. J. C. Meem was requested to cast one ballot in favor of the ticket presented on November 9th by the Nominating Committee. Mr. Meem reported that the ballot had been cast and the President thereupon declared the following elected as the officers for 1912:

For President, WILLIAM T. DONNELLY

Secretary, JOSEPH STRACHAN

Treasurer, JAMES W. NELSON

Director, HENRY W. WOODCOCK

Director, E. M. VAN NORDEN

<i>Auditing Committee,</i>	{	R. L. WILLIAMS
		W. W. BRUSH
		H. P. MORAN

each for the term of one year.

The newly elected President was at once inducted into office, and after thanking the members for the honor conferred upon him, he, upon motion duly carried, declared the meeting adjourned.

BROOKLYN ENGINEERS' CLUB.

No. 100.

THE HYDRO-ELECTRIC DEVELOPMENT OF THE GREAT WESTERN POWER COMPANY

BY H. P. RUST.

PRESENTED JANUARY 12, 1911.

California has been the pioneer State in the electrical development of water powers in connection with high voltage, long distance transmission lines.

At first, the plants were small, as the power market to be supplied was limited, and they were soon surpassed in size by other developments in different parts of the country where the demand for power was much greater. However, the amount of power used in the West has been increasing lately at a very rapid rate, so that recently it has proven profitable to build a large water power plant in California, which in point of size, efficiency and permanence of construction, is equal to any of the developments in the East.

The Great Western Power Company of San Francisco have recently completed the largest hydro-electric power station in the West, but this plant represents only a small part of the power which the company can ultimately obtain from its properties which have not yet been developed. In fact, the whole scheme of development which they are now going ahead with, will, when finished, be as large as any water power plant which has yet been contemplated.

The development is on the North Fork of the Feather River, a branch of the Sacramento River, which rises in the Sierra Nevada Mountains in the Northeastern part of California. The power house is at Big Bend, 18 miles above Oroville, and 160 miles from San Francisco, where most of the power is used.

At Big Bend, as the name would indicate, the river makes a long detour of a horse-shoe shape; the distance around the bend is about 11 miles, but the distance across the neck of land is only 3 miles. The natural fall in the river in this distance is 413 ft.

By means of a dam at the upper end of the bend the flow of the river is diverted into a pressure tunnel 3 miles long, across the neck of land, to the power house at the lower end of the bend where the total fall in this length of the river can be obtained. Here there are at present 4 units installed,

each of 15 000 horse-power or 60 000 horse-power in all. The station is only one-half the size to which it will ultimately be built, but the tunnel is large enough for 4 more units.

DRAINAGE AREA.

The drainage area of the river above Big Bend is 1 954 sq. miles. The low flow in an average year is about 1 000 cu. ft. per second or about $\frac{1}{2}$ sec. ft. per sq. mile. It is estimated that in a dry year, such as may occur once in 25 years, the flow may drop to about 750 sec. ft., and that in a dry period which occurred 50 years ago it may have been as low as 50 sec. ft.

The rainfall nearly all comes in a few heavy storms during the Winter; and during about five months in the Summer there is no rain. The greatest recorded flood is 125 000 sec. ft., which occurred in February, 1907.

The 4 units in the station now require about 1 000 sec. ft. when operating at 70% load factor and before more units can be installed the dry season flow will have to be increased by storage of flood waters for use during the Summer.

This part of the project was most carefully studied before work was started by Mr. J. R. Freeman, who made an extensive report on all the hydraulic features; and also by Mr. Emil Kuichling.

Fortunately there is an excellent site for an enormous storage reservoir at the head of the North Fork, 50 miles above Big Bend. Here there is a very large mountain valley, and by the construction of a comparatively small dam a reservoir may be formed which will be one of the best and largest that has yet been proposed.

The drainage area above the reservoir site is 500 sq. miles. It is about 40 miles long and about 20 miles wide. In the northwest corner is Mt. Lassen, probably the most recent active volcano in the United States, with an altitude of 10 000 ft. The western portion is all heavily timbered, but to the East, near the Nevada line, it becomes a sage brush country. The altitude of the reservoir is 4 500 ft. above sea level.

The prevalent winds during the Winter are from the southwest. The rain is all from these moisture-laden winds from the Pacific which is precipitated when it strikes the mountains. It is on this account that the rainfall is much greater on the western part of the drainage area than on the eastern part.

The average precipitation over this drainage area is 48 ins. yearly, but it varies from 75 ins. on the West side to 30 ins. on the East side. The run-off averages about 28 ins., or 50%.

The reservoir site at Big Meadows is a large mountain meadow about 40 sq. miles in area, which can be overflowed to an average depth of 40

ft. by a masonry dam across the canyon at the lower end of the meadows. This dam will only be about 100 ft. high above the present water level and 135 ft. above solid rock. It will be about 800 ft. long on the crest.

The reservoir will contain over 40 billion cu. ft., and to show the large size of it, the capacity of other large reservoirs may be mentioned: New Croton Reservoir $4\frac{1}{4}$ billion cu. ft.; Ashokan Reservoir 9 billion cu. ft.; Roosevelt Dam, Salt River, 56 billion cu. ft.; Reservoir on the Rio Conchos, formed by the dam of the Mexican Northern Power Co., near Chihuahua, Mexico, now being built, 70 billion cu. ft. However, as the Big Meadows dam will be only about half the height of any of those mentioned, the natural advantages of the site are much greater.

Aside from the possible storage in this reservoir, the present sustained flow from the valley during the dry season is remarkable. The low flow in an average year from the 503 sq. miles is 500 sec. ft. So that this watershed which is only one-fourth of the total above Big Bend, furnishes one-half of the low flow passing there, and in fact it furnishes practically half of the low flow passing Oroville where the drainage area is about seven times as large as above Big Meadows.

The reason for this, is the large underground flow coming from certain parts of the valley and appearing as large springs which have a constant flow the year round. The northern part of the watershed lies within the limits of the great lava flows of Oregon and northern California, and Lassen peak is surrounded with large deposits of fissured lava, porous cinder and ashes, which form a natural subterranean reservoir, in which flood water is stored and runs off in the dry season, perhaps two or three years after it has fallen.

Contrary to the usual ideas, melting snows on the high mountain peaks are found to add nothing to the late Summer flow. This all comes from the underground flow, and the snows then evaporate rather than melt.

By means of the reservoir it will be possible to regulate the flow at Big Bend so as to always have 1 800 sec. ft. there, or the low flow there will be practically doubled.

POSSIBLE DEVELOPMENTS.

Immediately downstream from the reservoir dam is a long series of steep rapids and cascades and the river falls 2 000 ft. in a distance of 14 miles. Here about 200 000 horse-power can be developed when the market shall have grown sufficiently to use it.

Further downstream there are other falls aggregating about 500 ft. before coming to Big Bend, so that in all 400 000 horse-power can be developed along the river.

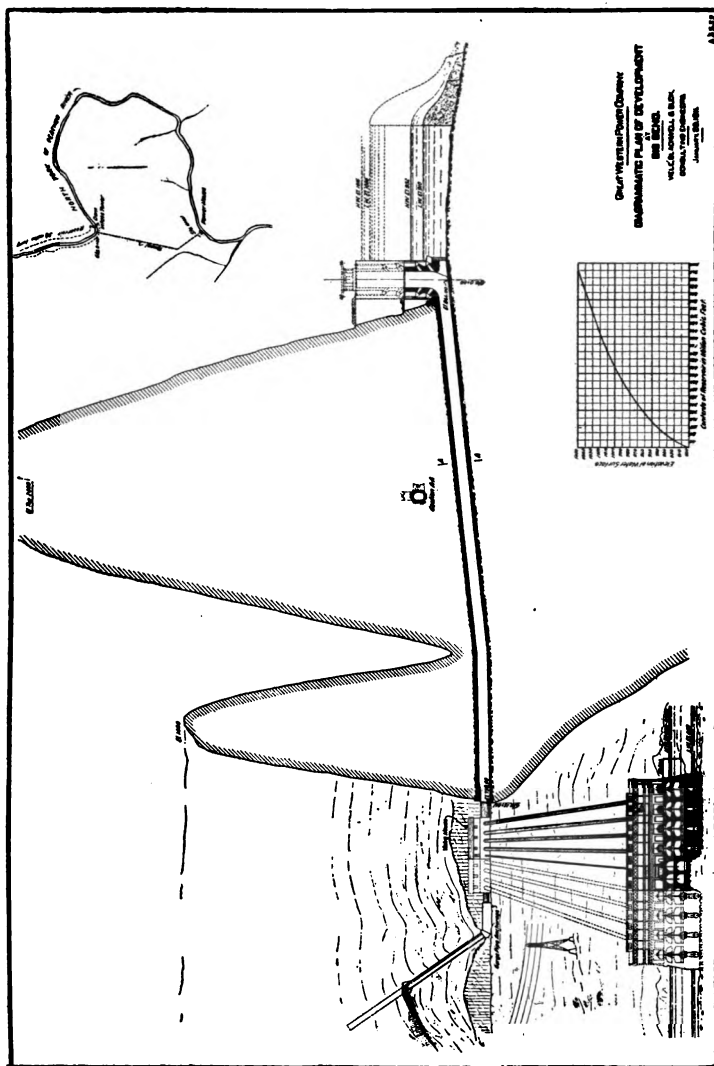


FIG. 2.—DIAGRAMMATIC PLAN OF DEVELOPMENT (AT BIG BEND).

However, the Big Bend site is much nearer San Francisco and more accessible, and for many other reasons it was considered the best, so that this plant has been built first.

BIG BEND DEVELOPMENT.

As explained before, the development consists of a concrete diverting dam 40 ft. high, which will finally be raised to 130 ft. in height above the original water level.

This dam turns the flow through a concrete lined pressure tunnel three miles long. Part of this tunnel is an old mining tunnel, formerly used to drain the river bed around the bend, which has been enlarged and lined. At the outlet there is a riveted steel header pipe securely concreted into the end of the tunnel. This branches into four smaller penstocks down the side of the canyon and connects with each of the four turbines in the power house below.

The end of the header pipe is turned up the hillside to a level 35 ft. higher than the crest of the dam and forms a surge pipe, or vent, and prevents any excessive pressure of water hammer in the tunnel due to quick closure of the turbine gates.

The problem of the development was a peculiar one and there are several conditions which make it unlike any other in the West.

First, there was the old mining tunnel which had to be used. This had a steep grade and a fall of 70 ft., too much to be wasted by using a gravity tunnel, so this necessitated a pressure tunnel. A new tunnel or extension was necessary from the exit of the old one in Dark Canyon to the main river 3 400 ft. long, to obtain all the head available with the shortest possible head-race. With a pressure tunnel and pipe lines, all enclosed, the quantity of water flowing could be quickly changed, thus allowing for changes in the load on the generator without having to waste water over spillways, as would be necessary with a gravity conduit, in which the flow would have to be constant nearly all the time.

The pressure tunnel allowed the use of a high dam at the intake to increase the head, and to form a balancing reservoir to carry daily peak loads or store water over Sunday. With such a reservoir no water need be wasted on account of any load factor which may be obtained for the plant, and the average flow during the day could be stored when the load was light and used when the demand for power was at its greatest. By means of the reservoir and pressure tunnel the amount of water which could be obtained from the low flow in the river is increased from 50 to 60%.

The chief disadvantage of a pressure tunnel in such a case is the difficulty of taking care of the water hammer and providing for close regula-

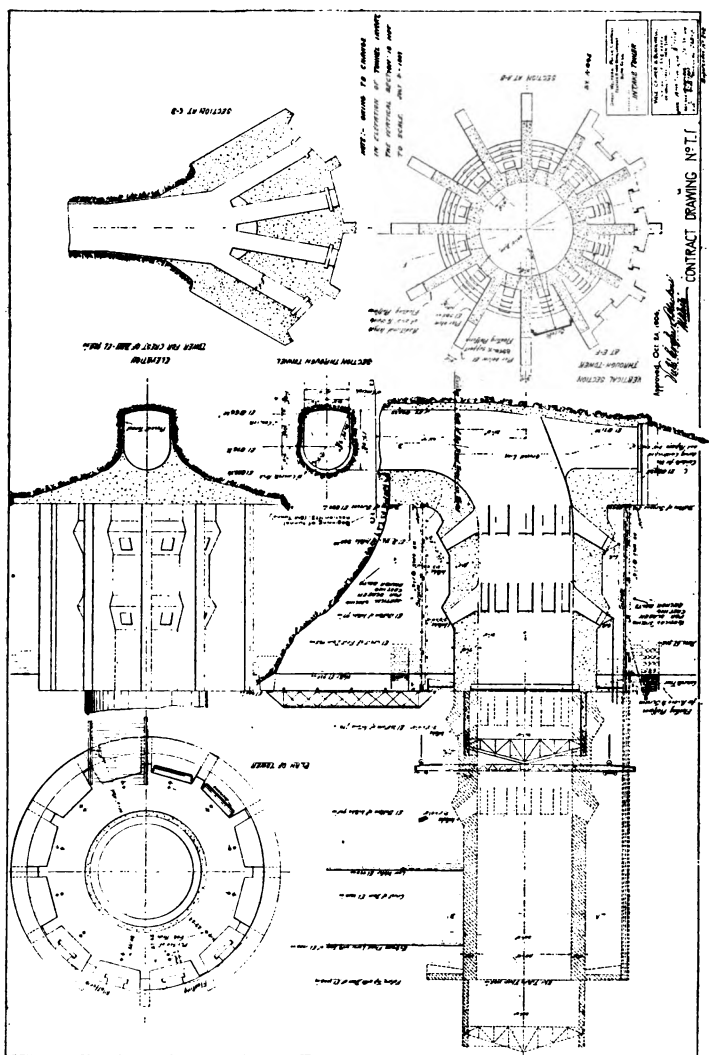


FIG. 4.—DRAWING OF INTAKE TOWER.

tion, but by special precautions afterwards described this may be safely taken care of.

This design necessitated engineering and construction work of a high character, much more so than is customary with most power plants in the West.

In order to get the plant started as soon as possible and cheapen the first cost, only half the power was first built and the high dam has been deferred. But the tunnel has been made large enough and all connections

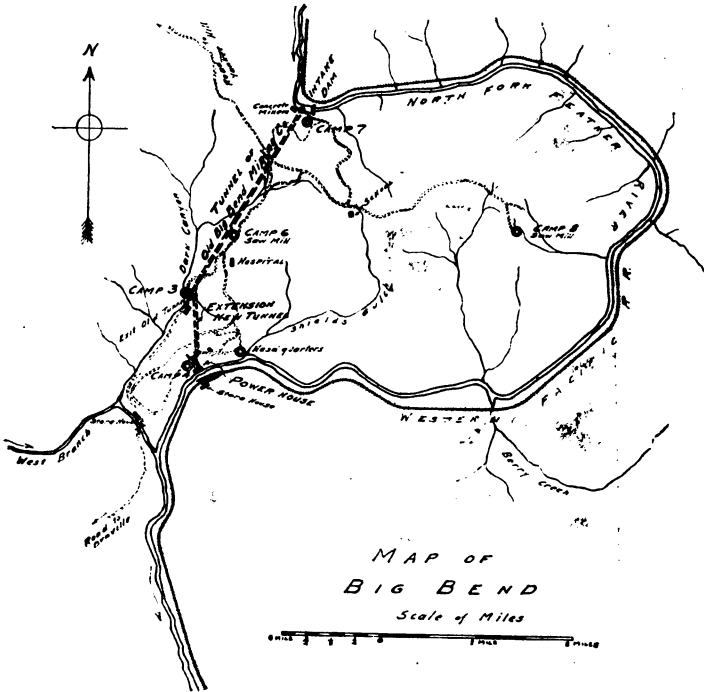


FIG. 3.—MAP OF BIG BEND.

provided so that the power house may be doubled and four more units installed without interfering with the operation of the first installation.

Before describing in detail the different portions of the work, the construction plant and camp should be described.

CONSTRUCTION PLANT AND CAMPS.

The main problem before the railroad was completed, as far as the work, was transportation. This had been promised for early in the Summer of the first year's work, but the railroad engineers also had their troubles.

and it was not in operation as far as the power house until the following Spring. During this time all supplies and plant had to be hauled 20 miles from Oroville.

About 25 miles of new roads were built into the different camps and the saw mills.

Work was started in the Fall of 1906, and the weather during the first Winter was very bad. There was a great deal of rain and snow and the roads were almost impassible. However, sufficient plant, boilers, compressors and supplies had to be hauled in to start the tunnel excavation.

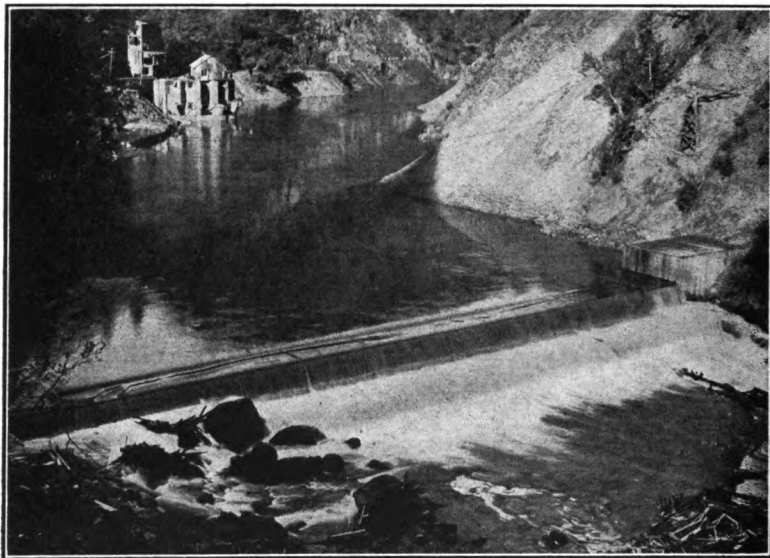


FIG. 5.—TEMPORARY TIMBER DAM AND INTAKE TOWER.

At the intake there was a camp (Camp No. 7), accommodating about 300 men.

Besides the concrete plant here, there was a 1250 cu. ft. steam-driven compressor and boilers, etc.

The principal Camp (Camp No. 3), was in Dark Canyon, at the exit of the old tunnel. Here there were accommodations for about 600 men and the principal repair shops, etc.

The camp at south portal above the power house (Camp No. 4), had accommodations for about 300 men.

Besides these, there were two saw mills, Camp No. 6 and Camp No. 8, each with a capacity of 10000 ft. of lumber per day; and also the headquarters, Camp No. 1, and the various store-houses, commissaries, etc.

As the work was carried on shortly after the San Francisco fire, labor was very scarce and of poor quality. The maximum force was about 1 600 men and it averaged 1 200 most of the time.

No contractor could be found who would undertake the work at a reasonable price, as all who were asked to bid seemed afraid of the inaccessibility of the site, so all the work at Big Bend was carried on by the engineers by day labor.

Among other troubles, there were two severe floods, the first of which washed away most of the buildings in the headquarters camp, and one bad forest fire which burned over a large portion of the Company's property at Big Bend and endangered the camps and equipment.

INTAKE TOWER.

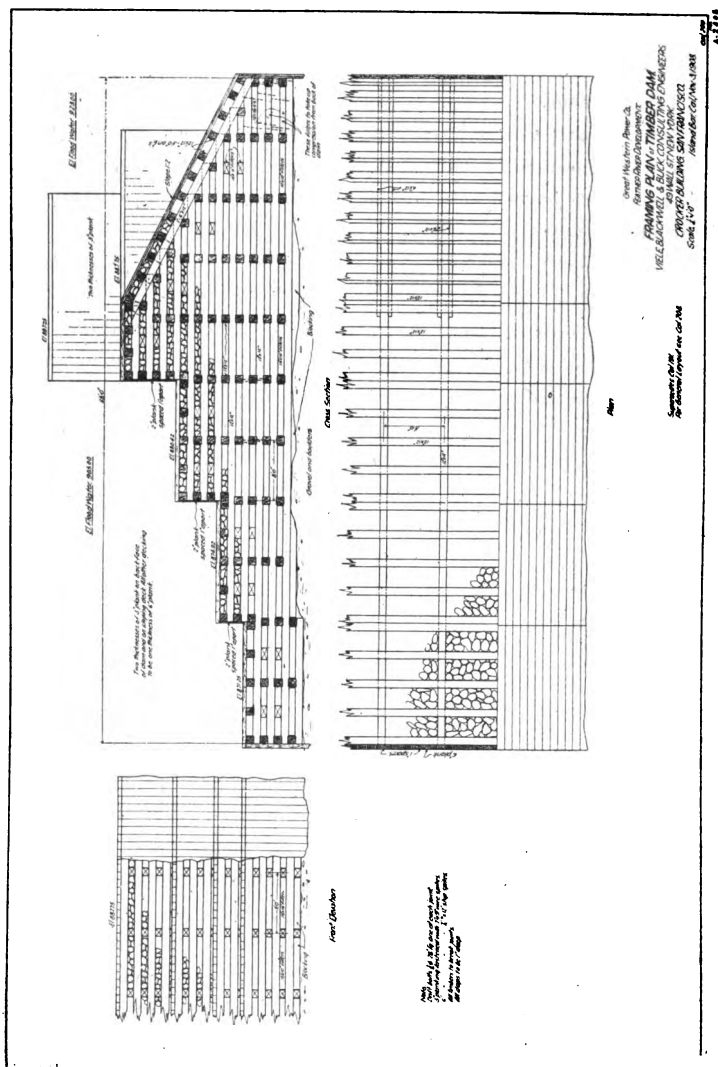
In order to control the water entering the tunnel at all levels at which the water might stand in the reservoir, and also to provide access to the tunnel from this end, a concrete gate tower has been constructed. It is of somewhat unusual construction and is a massive piece of work. It consists of a heavy hollow concrete cylinder 28 ft. in inside diameter, with walls from 12 to 7 ft. thick; it is now finished to El. 940 or 76 ft. high, but, when the high dam is built, will be 163 ft. high.

Around the outside there are 12 buttresses 3 ft. thick, between which there are now 2 tiers, but ultimately 4 tiers, of 12 flap gates; making in all 24 gates now in use, and ultimately there will be 48. They are each 3 ft. 4 in. x 4 ft. 0 in. in the clear and are made of steel plate. The frames, however, are cast iron. The gates can be opened by the rod extending up to the floor, which is lifted by a hand-operated crane. Their principal advantage is that they can be closed so easily; by simply releasing the rod at the top, they close of their own accord, so that in case of accident all the gates can be closed very quickly and it does not require any power. In opening them one of the upper gates, which does not require much power, is first opened, allowing the tunnel to fill gradually and equalize the pressure on each side, so that the lower ones can then be easily opened.

Outside the gates and between the buttresses are the screens. These are made up of $2\frac{1}{2}$ in. x $\frac{3}{8}$ in. flats, spaced 2 ins. apart, and slide into C. I. grooves bolted to the side of the buttresses. They are arranged to be raked from a floating platform fitting between the buttresses.

This arrangement allows water to be taken from nearer the surface and ensures freedom from sand, silt or debris. It also gives large rack and gate area with a minimum of masonry.

In order to start the plant before the dam was finished, 4 temporary openings were left through the bottom of the tower. These were controlled



temporarily by steel and redwood gates, motor operated. But since the completion of the dam they have been closed permanently and will not be used in the future.

During construction of the tower access to the tunnel had to be allowed for, as it was being enlarged and lined at the same time. A crushing and concrete mixing plant was erected near the tower and concrete was mixed here for both the tower and for lining this end of the tunnel. A quarry of hard trap rock was opened up just upstream. There was also a compres-

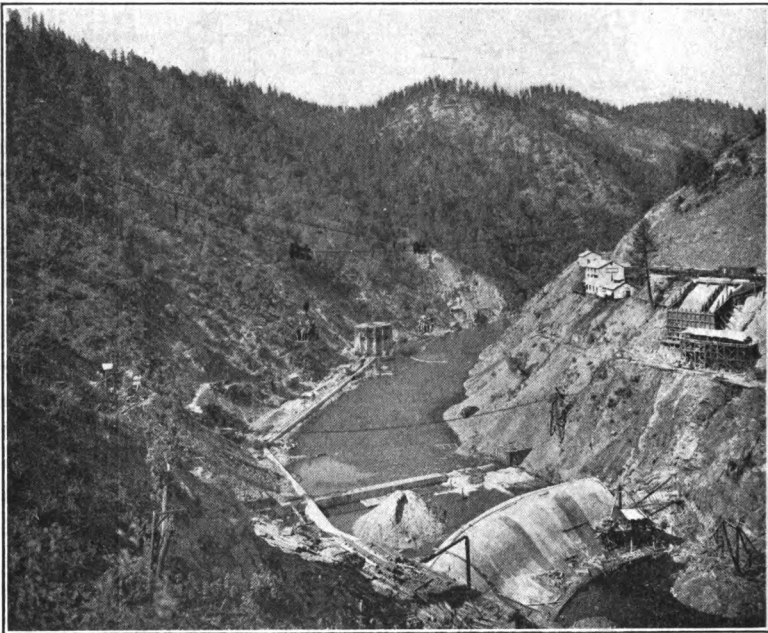


FIG. 7.—VIEW OF MASONRY DAM AND INTAKE TOWER.

sor located here of 1 250 cu. ft. per min. capacity to supply compressed air to this end of the tunnel.

No sand for concrete could be obtained nearby, so 2 sets of 24-in. crushing rolls were installed in the crushing plant to crush rock fine enough for use as sand.

There was not room for a camp and quarters near the river, so this was located about 350 ft. higher up the canyon side, above the tower, with accommodations for about 300 men.

TIMBER DAM.

In order not to interfere with work in the tunnel and protect this end of it from a higher water level, the intake tower had to be practically fin-

ished before the diverting dam could be started. Work on the tower could not be rushed without interfering with work in the tunnel, so that it required all the first working year to complete the tower and the dam could not be started until the second Summer.

In order to get the plant started as soon as possible, this left only one season in which to build a dam and it would have been impossible to put in the foundations and build a masonry dam in one Summer, only about six months. So it was decided to build a temporary timber dam sufficiently high to turn the water through the lower sluiceways of the intake tower and build the masonry dam later.

The timber dam was located just above the site for the masonry dam, and built so it would later act as a coffer-dam for the masonry dam. It is about 700 ft. downstream from the intake tower.

Also, as the Western Pacific R. R. was not finished as far as the intake, the cost of cement and sand would at that time have been excessive for the construction of any large amount of masonry.

The timber dam is shown in plan and cross-section. It has a slope of 2 in 1 on the upstream side, a level crest $10\frac{1}{2}$ ft. wide and three steps on the downstream side, each 16 ft. wide. It was arranged so 8 ft. of flash-boards could be added on the crest.

The crest is 22 ft. above the tunnel invert at the intake. It is about 18 ft. above the original water, or about 26 ft. above the river bottom, and is about 280 ft. long. The dam is built of 12-in. x 12-in. square timbers bolted together with $\frac{7}{8}$ -in. drift bolts 26 in. long. Additional longitudinals and rakers are spaced 4 ft. apart to support the deck. This is made of two layers of 3-in. plank on the upstream face and of one layer of 6-in. plank on the crest and the downstream face.

The dam was built in the dry between two coffer-dams. It is founded on solid rock at each end, but in the center of the river rests on the boulders and hard pan of the river bottom. A row of timber sheet piling was driven along the upstream face to prevent leakage under the dam.

During the first Winter it successfully withstood a flood of 95 000 sec. ft., about three-fourths the maximum expected in the river. This overtopped the crest about 22 ft. No leaks developed, except one at the end, through a crevice in the rock, and the pond above was filled with so much silt it made the dam quite tight.

However, the large amount of silt in the water caused a sand blast action, which wore away the decking in some places from 2 in. to 4 in.

The timber for the dam was all obtained from the Company's property near Camp 8, on the east side of the Bend, and was sawn at the mill there. It is mostly pine.

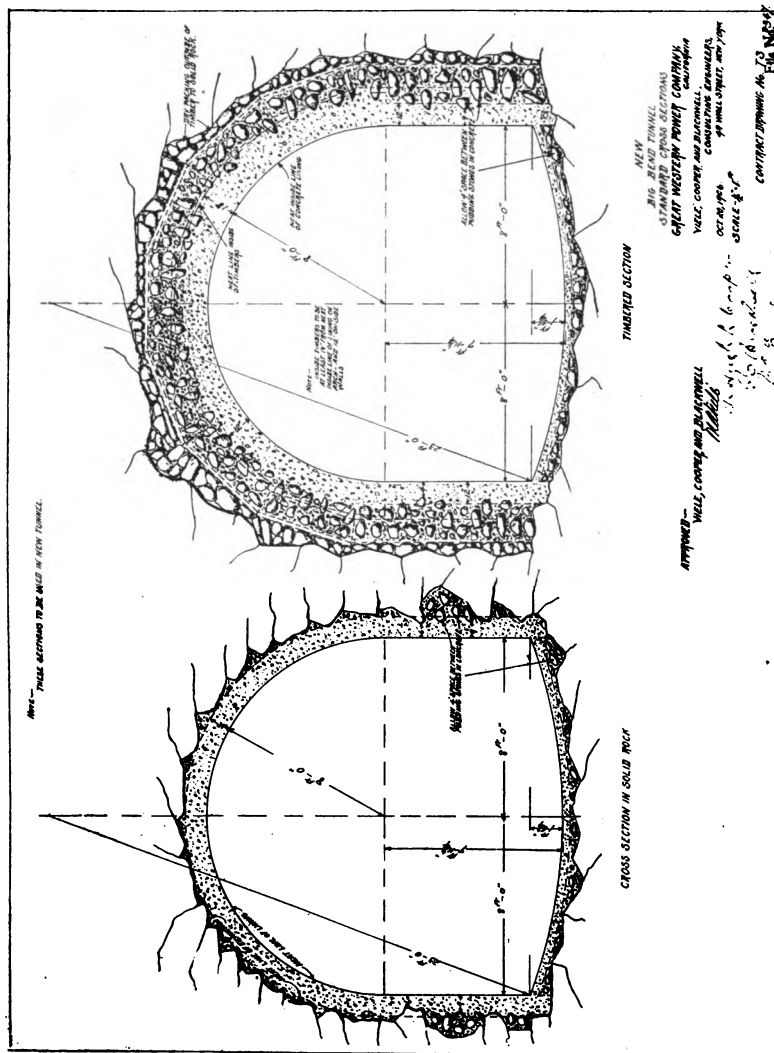


FIG. 9.—CROSS SECTIONS OF NEW TUNNEL.

PERMANENT DAM.

The masonry dam was not started for a year after the timber dam was finished, and has just been finished up to El. 920. It is about 300 ft. long on the crest and is 50 ft. high above the river. It is high enough to turn the water through the gates of the intake tower and to form a regulating reservoir to store water for the daily peak loads and enable the station to operate at any load factor without wasting water.

It has a gravity Ogee section of cyclopean concrete masonry, and is very broad at the base on account of the severe floods. The maximum flood will overtop the crest about 23 ft.

The foundation is a very hard and tough diorite rock, locally called greenstone. The bottom of the river was covered with large boulders and gravel, which had to be excavated. The lowest point of the foundation is 45 ft. below the original water level.

In constructing the dam a new camp and quarters were built. Four Lidgerwood cableways were used and a large new rock crusher plant and concrete mixing plant installed.

Of course, it is intended, as explained before, that this dam will ultimately be built 90 ft. higher.

TUNNELS.

As was shown on the map, the old tunnel of the Big Bend Mining Co. only discharged into Dark Canyon, and did not go completely across the neck of land to the main river below.

This old tunnel has quite an interesting history. It was started in 1883 at the time placer gold mining was booming in that part of California, the idea being to divert all the dry season flow of the river through the tunnel 12 300 ft. long to Dark Canyon, and leave the river around the bend dry, thus allowing the Company during the Summer to work the gravels and sand in the river bed and extract the gold which was supposed to be there.

The tunnel was started from the Dark Canyon end, and required three years to complete. It was about 8 ft. high by 13 ft. wide and had a grade of 5 per 1000. The progress was rapid, 400 ft. being made one month. A timber diverting dam was built across the river just below the intake, but when the water was turned through the tunnel it was found that unfortunately the tunnel had not been made large enough, and would not take nearly all the Summer flow. It was then enlarged, requiring another year, by taking 4 ft. more from the roof of the tunnel, making it 12 ft. x 13 ft. in cross-section. The cost of the complete tunnel was then \$750 000.

Work was started prospecting the river in 1888, but with poor success. The next year the Company spent \$100 000 to obtain about \$40 000 worth of gold, hardly a paying proposition, so the project was abandoned.

The tunnel then lay idle until purchased by the Great Western Power Company to be used as part of their development.

The maximum flow required in the tunnels is 2 500 sec. ft. The maximum allowable velocity decided on was 11 ft. per second, so the net cross-section was made 220 sq. ft. inside the concrete lining.

The old tunnel measured about 12 ft. x 13 ft., so it had to be considerably enlarged. It was made of a horse-shoe section 18 ft. high by 14 ft. wide inside the lining, or 20 ft. x 16 ft. outside the lining. The enlargement was made by taking from 5 to 6 ft. from the roof and by trimming 2 to 4 ft. from one side. This is the reason for making the section so high in comparison with its width, as it was considered more economically in making the enlargement to take as much from the roof as possible.

The 3 400 ft. extension, or new tunnel, being entirely new, could be made a better section. As shown, it is 16 ft. wide by 16 ft. high inside the lining, horse-shoe shape, but of the same net area.

The concrete lining is intended to be 12 in. thick. The minimum allowed on the sides and arch was 6 in., and 4 in. on the invert. From careful cross-section taken with a sunflower the actual thickness averaged 21 inches.

At the intake the invert is 54 ft. below the present crest of the dam; throughout the new tunnel and in the header pipe about 120 ft. below. When the dam is raised to its final height, the header pipe will be 200 ft. below, and the tunnel has to withstand the internal pressure due to this.

The ground is solid rock throughout. The new tunnel and both ends of the old tunnel are through shale, but about 6 000 ft. in the middle of the old tunnel is through a very hard and tough blue trap, really a diorite.

The surface of the ground is mostly from 400 to 1 500 ft. above the tunnel and all rock. The few springs encountered in the tunnel or appearing along the canyon side, tended to show that the ground water level was much higher than that necessary to counteract the internal pressure in the tunnel. On this account weepers (2 in. diam. pipe) were placed in the lining to relieve any pressure from the outside, one for each 100 sq. ft. of lining, and extra ones where any springs were encountered. However, the tunnel was very dry, and none were struck which gave more than what a 1-in. pipe would carry.

There were, however, three exceptions where all weepers were omitted and the lining was made at least 24 in. thick. First, for about 200 ft. in from the intake. Second, for about 400 ft., where the new tunnel branched

off from the old and ran under Dark Canyon. At one point here there is only 80 ft. of rock overlaying the tunnel. Third, for about 373 ft. in from the header pipe or to a point 500 ft. away from the portal above the power house. Great care was taken at these places to secure dense concrete closely packed against the rock.

In the other parts of the tunnel the rock is depended on to take the pressures, and the lining is considered merely as a means to obtain a smooth tube with small hydraulic losses. In fact, one engineer seriously proposed lining the tunnel with planed red-wood timbers supported on concrete cradles.

The proportions of the concrete mix were 1:3:5 Puddling stones were embedded in the concrete where possible, keeping them 6 in. from the face. Very little timbering was necessary except at each portal. At the intake end and throughout the tunnel the timbering was all left in place; but at the portal above the power house it was removed, before the lining was placed.

The exit into Dark Canyon was closed by a concrete bulkhead 25 ft. thick. Two 12-in. pipes fitted with gate valves were left through this to drain the tunnel and act as sand traps.

The excavation from the roof of the old tunnel was carried on from heavy traveling timber platforms 24 ft. long. The rock was blasted directly

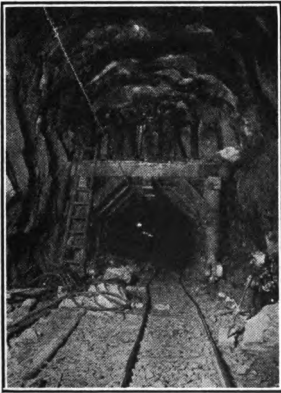


FIG. 10.—TRAVELING TIMBER PLATFORM FOR ENLARGING OLD TUNNEL.

onto these, then mucked into the cars below, and hauled away by electric locomotives. There were generally three platforms for each gang of miners, drilling being done on one, while mucking from a second and moving the third ahead. Twenty travelers, or jumbos, were required in all, a number being broken in the hard trap rock. The progress varied according to the hardness of the rock, from 10 ft. per day to 3 ft. per day per gang of men.

The new tunnel was driven with a full width heading followed by a single lift bench. It was worked from both ends; that is, from Dark Canyon, and also from the power house end. The result was a maximum progress of 64 ft. a week in each heading.

The lining was not started until the excavation was nearly finished, as it was considered better to wait until the Western Pacific R. R. was running as far as the power house, so cement and sand could be obtained at a reasonable cost, by saving the wagon haul from Oroville. On this account

it was necessary to rush the lining in every way possible when it did start.

The concrete was placed back of traveling forms operated in sets, made of timber. Each set consisted of an air hoist, 60 ft. of side wall forms and 60 ft. of arch forms.

These were arranged so the forms could be released as soon as the concrete had set and the carriage run ahead on rails to its new position.

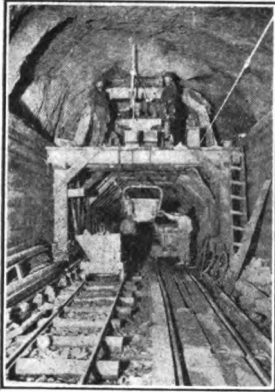


FIG. 11.—VIEW OF TRAVELING CONCRETE FORMS FOR TUNNEL LINING.

A 60-ft. form could be released, run ahead and set up again in from 3 to 6 hours by a small gang of men.

One gang operated two sets of these forms and would fill one while the concrete was setting behind the other. From four to five gangs, both day and night, were employed, and the record progress was the equivalent of 800 ft. of complete lining in one week.

The concrete was all mixed outside the tunnel and was hauled in by the electric locomotives.

There were three mixing plants, one at the intake, one above the power house and one in Dark Canyon. Each consisted of a No. 5 rock crusher and two $\frac{1}{2}$ c. y. Smith mixers. There were two sets of 24-in. crushing rolls at the intake to crush rock fine for use as sand. Sand for the other plants was obtained from Marysville, 46 miles down the river on the Western Pacific R. R.

At Dark Canyon was located the principal camp and equipment. It was crowded and inconvenient, as there was practically no level ground on which to place anything. There were accommodations here for about 600 men. There were three air compressors with a capacity of 3 500 cu. ft. per min., eleven 50-horse-power boilers, machine shop, blacksmith shop and the concrete plant. Cord wood was used for fuel until most of that in the district was burned, and then crude oil was used. Three hundred horse-power of electric power at 30 000 volts, was also obtained from the Oro Water, Light & Power Co. from a small station on the West Branch, 7 miles away.

HEADER PIPE.

At the lower end of the tunnel a riveted steel header pipe is embedded in the concrete lining for a distance of 125 ft. into the solid rock. It is 16 ft. 9 in. in diameter, the same area as the tunnel, and 1 in. thick. This thickness of plate is, of course, necessary on account of the pressure of 200 head, or 87 lbs. per sq. in., which there will ultimately be.

Emerging from the tunnel, it turns 46° to the right and continues on a bench cut in the rock of the hillside for a length of 112 ft., connecting at the end with the surge pipe 9 ft. diameter. In this length it is reduced in size in three tapered sections, first to 14 ft. 11 in. diameter, second to 12 ft. 6 in. diameter, third to 9 ft. 0 in. diameter.

From each of these four different diameters there are connections for two of the 5-ft. diameter penstocks running down the hill to the power house, and also a connection for the 24-in. exciter penstock. There are at present four main penstocks and the exciter penstock, and the four other connections are left for the future inlets.

The connections from the header pipe to the 5-ft. diameter penstocks are cast steel nipples. These were fitted to the header in the shop, and the holes for the $1\frac{1}{8}$ -in. connecting bolts were drilled in place. The bolts were $1\frac{1}{8}$ in. diameter turned to a driving fit with a nut on each end.

At the upper end of the penstocks are the valves. There are two valves for each penstock in series. First a pivot, or butterfly valve, hand operated, bolted directly to the nipple. Second, a motor-operated gate valve. Then a cast steel vertical elbow turning down the hillside on which is a 12-in. air valve to admit air to the pipe when the valve is closed and prevent a vacuum in the pipe. There is a 16-in. by-pass around both the valves. Immediately below this, on the hillside, is a cast steel gland expansion joint in each pipe.

The pivot valves have cast iron bodies and a cast steel gate, and give an unobstructed opening equal to 5 ft. diameter. Eight of these have been

installed, as they have also been placed on the connections for the four future units so that the future penstocks could be connected up without emptying the tunnel.

The object of these pivot valves is to enable the gate valves in case of accident to be repaired without having to empty the tunnel and shut down. They are an additional and cheap safeguard to the penstocks. Their cost is much less than the gate valves, but they

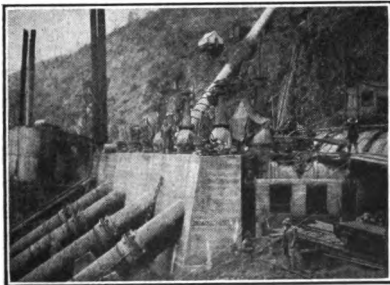


FIG. 12.—VIEW OF HEADER PIPE, SURGE PIPE AND GATES.

are quite satisfactory. They are designed for the ultimate pressure of 87 lbs. per sq. in., and did not leak any more than the gate valves under a pressure of about 50 lbs. per sq. in.

The motor-operated gate valves have cast steel bodies. They are elec-

trically controlled from a switchboard in the power house. There are also two 16-in. gate valves on the by-pass, one motor operated and remote controlled. This does away with the necessity of having an attendant here at all times to operate the valves.

The header pipe, of course, was all riveted up in the field. The plates for the 16 ft. 9 in. diameter section were 1 in. thick, and for the other diameters are $\frac{7}{8}$ in., $\frac{3}{4}$ in. and $\frac{1}{2}$ in. thick for the 14 ft. 11 in., the 12 ft. 6 in. and the 9 ft. 0 in. diameter, respectively. One and one-quarter in. and $1\frac{1}{8}$ -in. rivets were used in the heavy pipe, and as there was not room to use a compression riveter of the power necessary, pneumatic hammers had to be used. However, by considerable trouble and expense a very tight job was obtained even with these large rivets. The longitudinal joints are triple-riveted butt joints, and the transverse joints double-riveted butt joints. The pipe and valves are supported on concrete piers, and all the elbows have heavy concrete anchorages. The valves were supplied by the Pelton Water Wheel Co. of New York.

SURGE PIPE.

The surge pipe running up the hill from the end of the header extends to 25 ft. above the level of the crest of the dam. This has a very important duty to perform to relieve the water hammer when the turbine gates close, and to slowly stop the velocity of the water in the tunnel.

At present, with the 4 units the maximum flow in the tunnel is about 1100 sec. ft., and in case of a short circuit at times of full load, all this water is suddenly discharged from the spillway and flows down the small ravine to the left.

The spillway shown is only temporary, and when the masonry dam is completed the surge pipe will be raised about 100 ft. higher. Also, a large tank or standpipe or a concrete reservoir will be constructed connected to this. There is also a provision for connecting hydraulically-operated relief valves at the lower end of the penstocks. If found necessary, these can be installed later, and will help to relieve any water hammer.

The load on the station is a comparatively large one, and there are no sudden changes of any extent except for short circuits due to any line troubles which may occur. Such interruptions generally cause the turbine to shut down completely, and so speed regulation does not then matter. However, the tank to be later added will be a reservoir to supply water for any sudden increase of load which may be expected, until the flow in the tunnel has had time to be sufficiently accelerated.

This feature was carefully studied by Mr. R. D. Johnson, and is described by him in a paper read before the American Society of Mechanical Engineers.

Before going further, the construction plant installed at this point should be mentioned, and the chief feature is a 35-ton Lidgerwood Cableway, 1 200-ft. span between towers. The towers are of steel, and a 150 horsepower special hoisting engine is required to operate it. This was used for bringing all materials across from the Western Pacific R. R. The machinery for the power house was all lowered through a hatchway left in the roof of the building.

As at all the other camps, there was but very little room and no level ground except what was made by blasting a bench in the hillside. The boiler plant for operating the hoists, cableway, etc., was in front of the surge pipe. The rock crusher and concrete plant was about 400 ft. upstream from the header pipe with an inclined tramway to the power house. A quarry was opened up just to the upstream of the rock crusher.

The sand bins on the Western Pacific R. R. grade were located so sand could be dumped into them from the cars loaded by gravity into large skips on the cable, taken across the river to a bin at the tunnel portal and through the tunnel to camp 3 mixing plant, or to the mixers above the power house in dump cars.

Island Bar and the headquarters and operators' quarters are about half a mile upstream.

The transformer coils were the heaviest pieces of machinery to handle on the cableway, and weighed 35 tons each. If it had not been for the cableway an expensive bridge would have been necessary, but that would have been much more inconvenient.

PENSTOCKS.

The 4 main penstocks are 5 ft. in diameter, and the exciter pipe 2 ft. diameter. They are each about 600 ft. long. The pipes are lap-welded steel, and were made in Germany by the Actien Gescellschaft Ferrum at Kattowitz. The main pipes are made in 5 meter lengths, and vary from 10 mm. to 17 mm. in thickness. The connections are riveted, and have the Ferrum so-called "bump" joints.

The pipes are supported on concrete piers 30 ft. apart. The two vertical elbows are anchored by concrete piers to take the uplift due to the water pressure. There is a heavy anchorage at the bottom independent of the power house to take all thrust along the pipe so as not to exert any strain on the turbine casing. This lap-welded pipe was very satisfactory. It is smoother and lighter and, on the whole, more economical than riveted steel would have been.

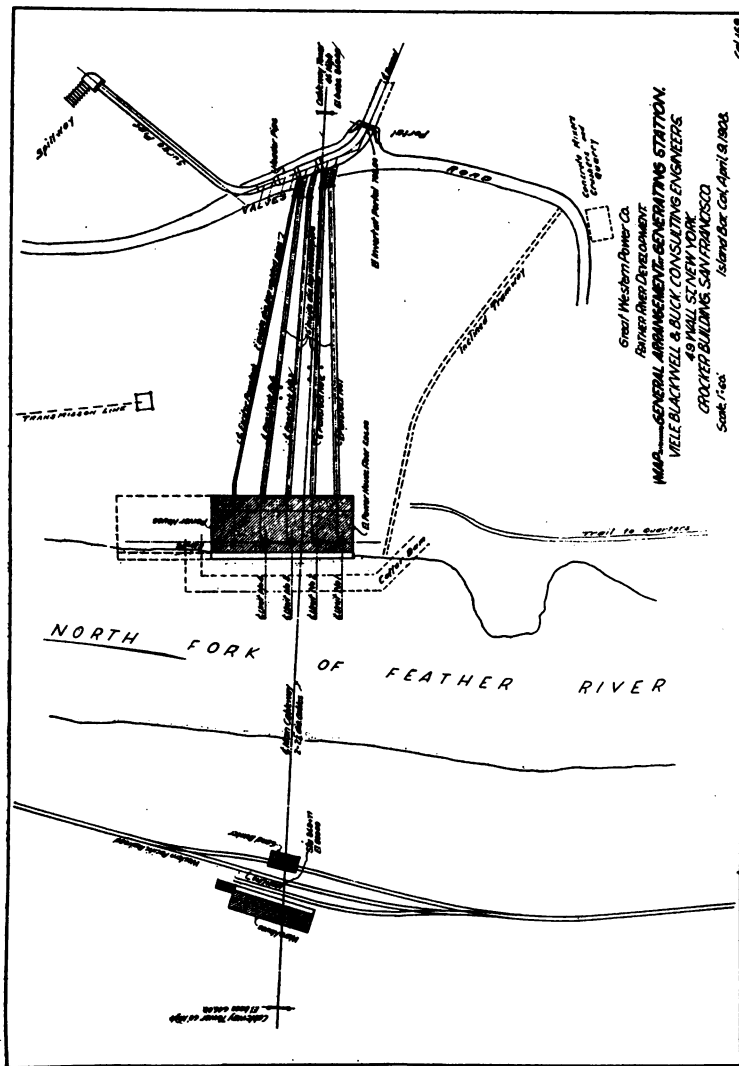


FIG. '13.—GENERAL LAYOUT OF POWER HOUSE AND PENSTOCKS.

POWER HOUSE.

In designing the power house the principal object kept in view was to have a structure which would withstand without question the great floods.

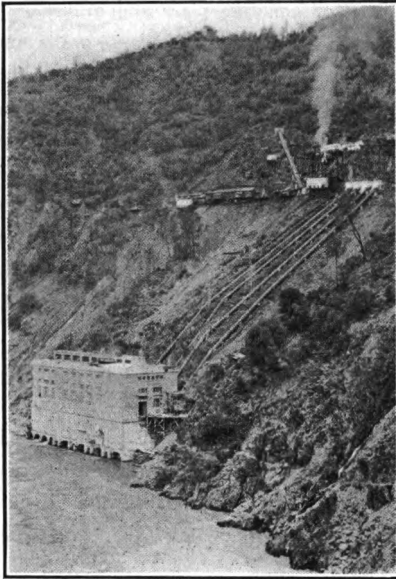


FIG. 14.—POWER HOUSE AND PENSTOCKS
POWER.

The ordinary low-water level is El. 457; the flood of February, 1907, was at El. 496, a rise of about 40 ft., and we cannot say but what a still higher flood might occur. It was considered necessary to have the electrical apparatus well above any possible high water, so the generator floor was located at El. 506, or 10 ft. above the high-water mark and 50 ft. above low-water. This difference in level, being too great for draft-tubes, necessitated the use of vertical shaft units (unless the 50 ft. difference in head from the generator floor to low-water were to be wasted), and also, as explained later, required the use of reaction turbines instead of, as is usual where such a high head

is involved, the Pelton type of impulse wheels.

The maximum practical head which can be obtained by draft tubes is about 20 ft., so the turbines were placed about 20 ft. above low-water at El. 477.5. But, as is seen, this would submerge them about 20 ft. below the high-water mark, and to protect them from that the turbines are placed in water-tight concrete chambers. The chambers are arched at each end to take the water pressure, and the wheels are founded on a large block of concrete, making the structure very heavy and certainly capable of resisting any possible flood.

There are heavy arched roofs above the turbine rooms which support the thrust bearings. These carry the weight of the revolving parts of the units. The thrust bearing rooms are in turn arched over to form the generator support.

The present building is for 4 main units and 2 exciters, but can be extended without interfering with the operation of the first part for 4 more main units.

The exciter turbines being small are of the impulse type, and are located on the main floor in the center of the ultimate building. Below these there are four chambers in which are located the auxiliary apparatus, oil pumps, drain pump, air compressors and a machine shop.

The rear of the building is supported on concrete piers and arches.

The *Superstructure* has a steel frame with reinforced concrete walls and roof. It is fire-proof throughout. The generator room in front is the full height of the building, and there is a 50-ton motor-operated crane running the length of it.

The rear of the building has two floors. On the main floor behind each generator are the transformers, and behind that the high-tension bus-bars. On the second floor above the transformers are the low-tension switches and bus-bars, and behind these and above the high-tension busses are the high-tension switches. All these are in separate concrete compartments or separated by concrete barriers.

On the second floor above the exciters is the main switchboard, and just below this on the main floor there is an auxiliary switchboard from which the auxiliary apparatus, oil pump, compressors, crane and station lighting, is controlled and also the motor-operated valves at the top of the penstocks.

On a mezzanine floor below the main switchboard are locker rooms, lavatory, etc.

TURBINES.

The turbines are interesting on account of their size and the high head under which they operate. The wheels have a capacity of 20 000 horse-power under the ultimate net head of 525 ft., and 15 000 horse-power under the present net head of 440 ft., and are as powerful as any yet built.

They are single runner, inward flow, Francis type reaction wheels, in a cast steel scroll casing and have a speed of 400 R. P. M. The penstocks connect directly to this casing, the only valves being at the upper end of the penstocks. The turbine-gates and guide-vanes are forged steel wickets.

All parts were given a hydro-static test in the shop to 400 lbs. per sq. in. and they are all designed for a working stress of twice the normal head or twice the normal speed.

A connection is left where an automatic relief valve can be installed to prevent water hammer if it becomes necessary.

The weight of the revolving parts, the runner and field of the generator is 145 000 lbs., and is supported by the oil pressure thrust bearing.

The speed is regulated by a specially designed governor of the double-floating lever type, working with 250 lbs. sq. in. oil pressure. The governor proper is located beside the generator and it admits oil to the two operat-

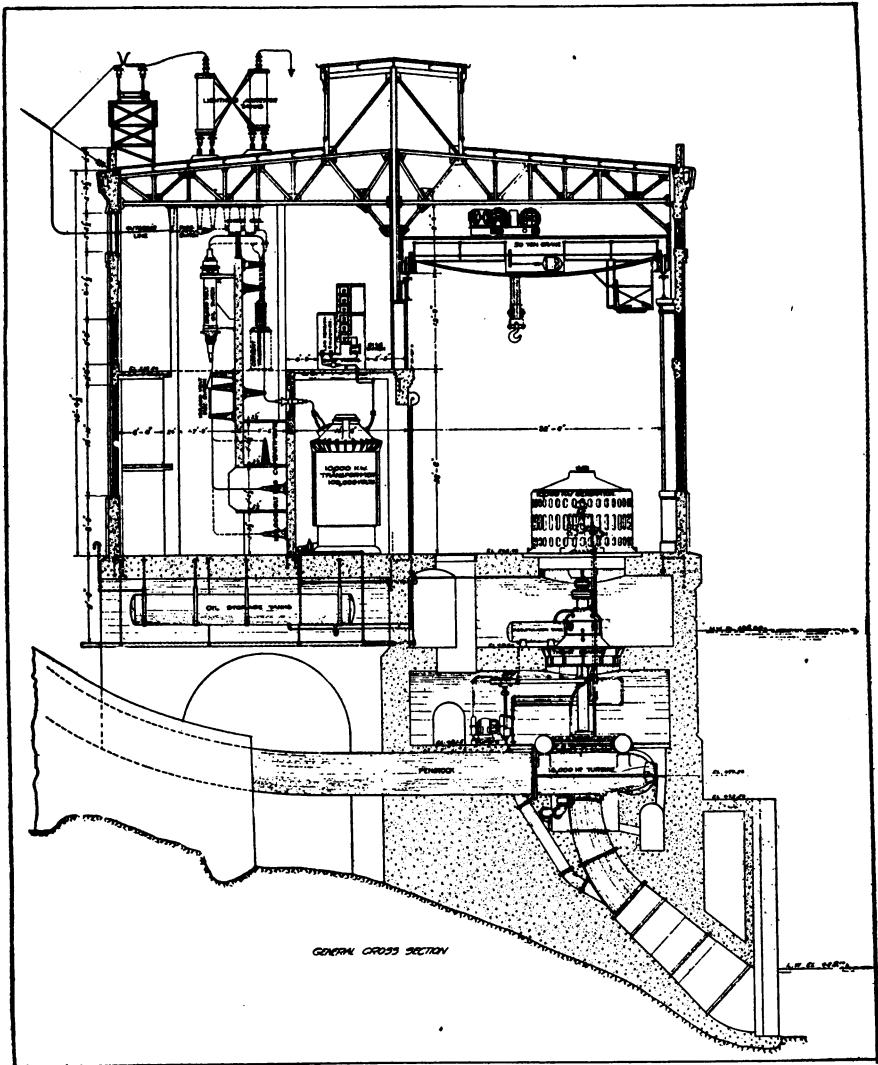


FIG. 15.—CROSS SECTION OF POWER HOUSE.

ing cylinders on the scroll casing to move the wicket-gates. These can also be hand operated and in case the oil pressure fails the gates can be closed with the water pressure by a connection to the penstock.

There is a speed limit device, consisting of a fly-ball mechanism attached to the main shaft, which will admit oil to the operating cylinders and close the gates, if the governor should get out of order and allow the speed to rise beyond a predetermined amount. This arrangement, however, only admits oil to the cylinders slowly, so that the gates cannot be closed so rapidly as to produce a dangerous water hammer in the penstock.

There are two oil pumps, one motor-driven, the other belted to the main shaft for each turbine. Each pump is sufficient to operate both the governor and the thrust bearing of its unit. These pumps are inter-connected, and connected to an accumulator tank so arranged that the pressure can be kept constant. When the governor is not in use the thrust bearing acts as a by-pass for the whole system.

As explained before, reaction turbines had to be used on account of the great difference between high and low water levels. Also on account of the large power, the characteristics of the reaction turbine are right for good efficiency. The specific speed in English units is about 21. All four turbines have been carefully tested, and show very high efficiencies. By varying the speed slightly it was found that the efficiency under the ultimate head, 525 ft., for which they were designated, will be 87%, at $\frac{3}{4}$ load. Under the present head the efficiency is from 84 to 85%, showing remarkably good design and construction.

The turbines were designed and made by the I. P. Morris Co. of Philadelphia.

ELECTRICAL APPARATUS.

The main generators are rated at 10 000 kw. They are 3-phase, 60 cycle, 11 000 volts, 400 R. P. M. machine, with revolving field directly connected to the water wheel, and are good for 50% overload. All the electrical apparatus was furnished by the General Electric Co.

The details of the motor were worked out with unusual care to withstand the high peripheral speed and still have the necessary weight and flywheel effect required in a water-wheel unit. They were given a double speed test at the shop, or 800 R. P. M., which meant a peripheral speed of 23 000 ft. per min. The design allows a maximum of ventilation without adding to the windage losses.

Their efficiency is 97.5% at full load and they will carry 12 500 kilowatts without heating over 40° C.

The two exciter sets each consist of a 500 horse-power impulse wheel, connected to a 250-kw., 250-volt, direct-current generator.

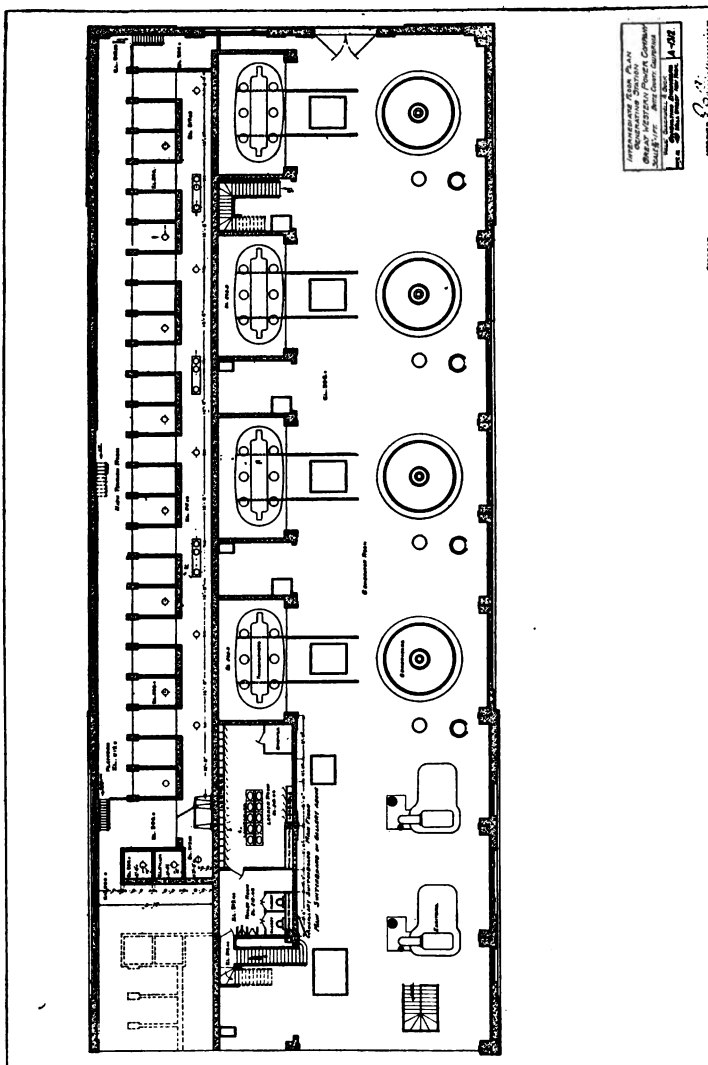


FIG. 16.—PLAN OF POWER HOUSE.

The transformers are rated at 10 000 kw., 110 000 volts delta on the high tension side and 11 000 volts delta on the low. They are on the shell type, oil-insulated and water-cooled. These transformers are the largest yet built. The coils are contained in a steel case and it requires 9 000 gals. of transformer oil for each.

They are tested at the shop and their efficiency is 98.9% at full load, practically a perfect machine.

The low-tension switches are of the H-type, solenoid oil switches, remote controlled from the switchboard.

This station was about the first designed for the high voltage, 100 000 volts, and all the high-tension apparatus had to be specially developed.

The high-tension switches are pneumatically operated and electrically controlled from the switchboard. The break is made in a cylinder of oil, but the contactors are moved by a piston under air-pressure of 80 lbs. per sq. in.

The switchboard is of the standard bench board type on a gallery projecting over the generator room. All connections are remote controlled from here.

The lightning arresters are of the aluminum cell type and are located on the roof.

TRANSMISSION LINES.

It is not the object of this paper to describe the transmission lines or distributing system of the Company, but for completeness the following gives some data regarding them.

The main line runs from the power house to Oakland, just across the bay from San Francisco, a distance of 160 miles. Here there is a terminal substation. There are also substations at Brighton, Sacramento and Cowell.

The line is a two-circuit, single steel tower line for 100 000 volts. The conductors are No. 000 stranded copper cable, supported by suspension insulators. Being about the first 100 000-volt line, most of the material was especially designed for it.

The standard towers are of galvanized steel, 75 ft. high, and the standard spacing is 750 ft. There is a $\frac{3}{8}$ -in. steel ground wire running along the top for lightning protection. Transpositions were made about once every $3\frac{1}{2}$ miles.

Various types of insulators were used: Lock and Thomas suspension and strain type and General Electric strain type.

The location of the line presented some difficulties and in order to shorten the distance from Sacramento to Oakland, the portion from Sacramento to

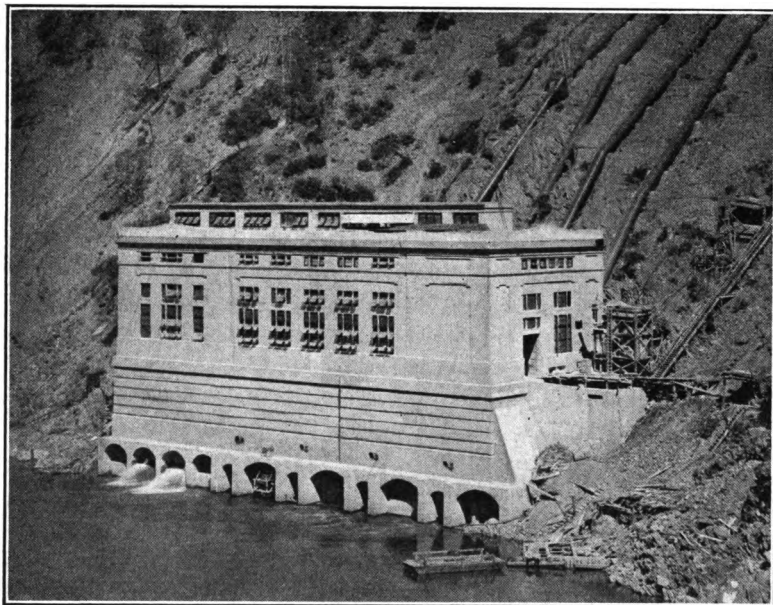


FIG. 17.—EXTERIOR VIEW OF POWER HOUSE.

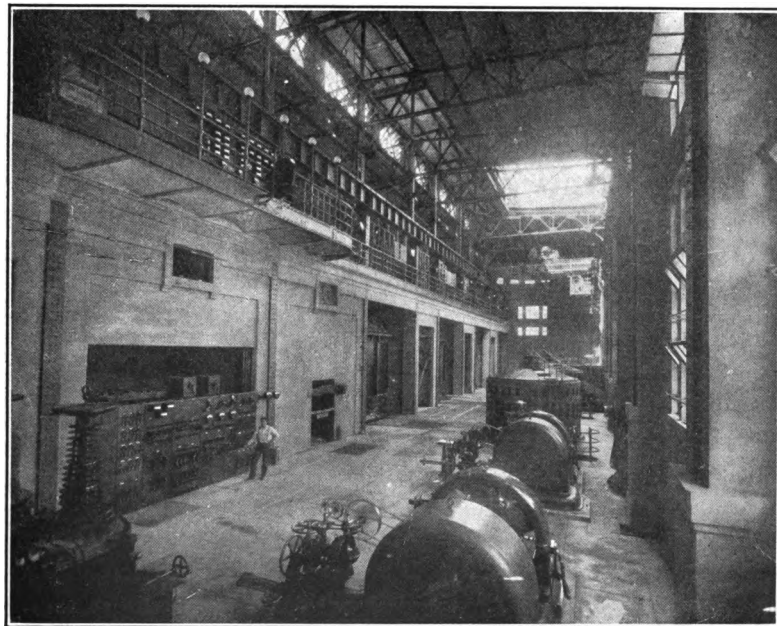


FIG. 18.—INTERIOR VIEW OF POWER HOUSE; GENERATOR ROOM.

Antioch runs through very low and swampy land. Of this, the portion shown is all of special construction with long spans and high towers supported on concrete and pile foundations. One span in particular across the San Joaquin River is very long, nearly 3 000 ft. The towers are nearly 300 ft. high, supported on concrete piers on piles and the conductors are copper clad steel cables stretched by counterweights.

In the terminal station at Oakland there are two 10 000-kw., three-phase, transformers, stepping down the voltage to 11 000, and 3 500-kw., three-phase transformers stepping down to 55 000 volts.

The Company have also an auxiliary steam station on the water front connected with this substation. It has now 10 000 kw. installed, 3 350 kw. horizontal Curtis steam turbo-generators. The station is built large enough for one more unit, and is arranged so it can be doubled in size.

The generators are three-phase, 11 000 volts, 60 cycles. They feed directly into the outgoing lines. The oil switches are remote controlled from a standard bench board.

The turbines run at 1 200 R. P. M. They are five-stage, and are the largest horizontal shaft Curtis turbines yet built.

There are six B. & W. oil-burning boilers with 6 000 sq. ft. heating surface each. The operating steam pressure is 210 lbs. sq. in. with 110° F. of superheat.

The efficiency shown by the test for full load at 205 lbs. pressure, 110° F. superheat and 28 ins. vacuum, was 14.9 lbs. water evaporated per kw. hour. The guarantee was 15 lbs. It required 24 500 B. t. u. per kw. hour, or 18 400 B. t. u. per horse-power hour. This corresponds to a thermal efficiency of 14.03%.

Oil being the only cheap fuel in San Francisco, it is relied upon entirely.

This steam station is merely a reserve plant and is at present but little used. It is intended for use only in case of accident to the hydraulic plant or transmission lines or to help out on high peak loads or in case of low water at Big Bend.

Mr. Edwin Hawley is president of the Company*; Mr. H. P. Wilson, secretary, and Mr. H. W. Sinclair, general manager. Viele, Blackwell and Buck are consulting engineers for the Company and carried on all the work except the construction of the masonry dam, which was done by the Company itself after the plant had started operating. Mr. M. A. Viele had immediate charge of the whole construction, and the writer was resident engineer at Big Bend.

DISCUSSION.

Mr. ENNIS.—There seems to have been nothing spared to obtain the best efficiency in the auxiliary steam plant. Is it expected to run this plant

*Died since writing of this paper.

for any large portion of the hours in a year, so as to make the extra expense in obtaining this high efficiency worth while?

Mr. RUST.—We do not expect that the plant will be operated very much, especially at first, as the load is not yet great enough to make it necessary; but later on it may be necessary to help carry the peak load with steam. In any case, the extra cost of the more efficient apparatus is comparatively small, and is likely to be more reliable. It was considered well worth while to have everything constructed according to the best practice.

Mr. DONNELLY.—Regarding the lap-welded pipe for the penstock, I understand it was brought from Germany. Was it cheaper to do that and pay the duty than to buy it in this country?

Mr. RUST.—We had to pay 35% duty, but we consider we saved money. Lap-welded pipe of this size is not yet made in the United States, and can only be obtained in Germany.

On account of the fact that the weld develops nearly the full strength of the plates and there are no riveted joints with their lack of efficiency the pipe could be made thinner. Also, as the pipe is smooth on the inside, the hydraulic conditions are better, and a somewhat smaller diameter pipe could be used. In this way a considerable weight of steel could be saved though the price per pound for the lap-welded pipe was higher. The lap-welded pipe is also easier to erect. In all we estimate we saved about 15% by using the German pipe.

Mr. VAN NORDEN.—I would like to ask if the buildings are all of reinforced concrete?

Mr. RUST.—Most of them have a steel frame with reinforced concrete walls.

Mr. STRACHAN.—Have you any figures of the cost of tunneling through the hard rock?

Mr. RUST.—I am sorry that I have none available. However, I might say that one of the contractors doing some work for the Western Pacific R. R. just across the river told me personally that he had taken some tunnel work in this same hard rock at a rather low price, and that before he got through one tunnel had actually cost him \$17 per yard.

This is the most expensive work I have heard of in the district, but it serves as an example to show how expensive work in that part of the country really is. However, our excavation in hard rock did not cost us nearly so much as that.

Mr. WILSON.—Is this power used to operate the Street Railways in San Francisco?

Mr. RUST.—Not in San Francisco, because the United Railways Co. now has its own water power plant on the Stanislaus River.

Mr. WILSON.—To supply power in the city, your transmission line would have to go around the Bay, would it not?

Mr. RUST.—We could either go around the Bay, which is quite a long distance or cross under it by submarine cables.

Mr. WILSON.—What is the highest voltage which could be used in such cables?

Mr. RUST.—We proposed to use 20 000 volts.

Mr. DONNELLY.—I would like to ask how a plant consisting of such a variety of work: tunneling, hydraulic and electrical engineering of so many different kinds, was handled by one firm of engineers?

Mr. RUST.—The construction and actual design was all in charge of the one firm, but they have made a specialty of such hydro-electric work, and, of course, have an organization of men who are expert in the different kinds of work comprised in such a plant. I might say, however, that Sargent & Lundy, of Chicago, were consulted regarding the design and construction of the steam installation in the auxiliary station. Also, as mentioned, the water supply, &c., was first studied by outside experts.

Mr. WREAKS.—Was there any trouble with the transmission line?

Mr. RUST.—Yes. Just after we started the first unit, there was a very bad storm, accompanied by the worst flood recorded in the Sacramento Valley. All the country from Sacramento to San Joaquin River crossing was overflowed. There was a very high wind at the time and about 11 miles of the tower line, which had not been made especially strong by special towers and concrete foundations as was that part of the line through low and swampy ground, collapsed. The water loosened the foundations, allowing them to yield slightly. This produced greater strains in the tower legs than they could stand.

Mr. BLUNT.—Regarding the intake dam; how is it proposed to raise it to its final height? What provision has been made in the present dam so it can be raised?

Mr. RUST.—No special provision has been made. The high dam will be of the same type as the present one, only very much wider on the base. The present dam is about 40 ft. high above water level, and the high dam will be 130 ft. Steps will have to be cut in the downstream face of the present dam and holes drilled and steel rods put in to bond the old and new work together.

Mr. JENNINGS.—Regarding the collapse of some of the transmission line towers; I wish to ask whether the fault was in the foundations or in the tower itself? If the tower had been heavier would the same accident have happened?

Mr. RUST.—These foundations were not concreted. The corner angle or stub had a bearing plate on the end, and was buried in the ground about 6 ft. This work was done in the dry season, and the back filling had not had time to become hard and compact around the stub, so that with an upward or side pressure there was not much to prevent the stub pulling out or being shoved sideways. The bottom bracing was at a very acute angle with the leg of the tower, and a slight movement sideways of the stub caused very severe secondary stresses in the leg and bracing. I think that if the stubs and bottom bracing and tower legs had been made heavier the accident would not have happened.

Mr. BLUNT.—The tower was of $\frac{1}{8}$ -in. material put together by bolts?

Mr. RUST.—Yes; most of the material was $\frac{1}{8}$ in. thick.

Mr. JENNINGS.—Was not the fall in line stopped by one of the standard towers?

Mr. RUST.—Yes. At one end of that part of the line which collapsed there was a standard tower with concrete foundations which stopped the

fall in that direction, so that I think the accident can be blamed on the foundations to some extent, and that if all the stubs had been concreted it might not have happened; but this would have been more expensive than making the towers heavier.

The same towers have been used in New York State, where climatic conditions are worse, the only difference being that the towers are closer together.

Mr. BLUNT.—How long is this line?

Mr. RUST.—It is about 160 miles.

Mr. FAST.—I would like to ask two questions. First, regarding the gate valves. Why would it not have been better to use hydraulically-operated valves instead of the motor-operated valves? In this way it would be possible to do away with the expensive gearing, motor, &c.

Second, regarding the thrust bearings of the main units, what type of bearing are they?

Mr. RUST.—No doubt hydraulically-operated valves have been satisfactory in many cases, but for the initial installation the pressure in the header pipe available to operate such valves is about 40 lbs. per sq. in., and finally it will be 87 lbs. per sq. in., so such valves would have had to be arranged to work with either pressure. Besides, we considered the motor-operated valves cheaper, and easier to control from the power house. Control from the power house was important, as this meant a saving in operation of the wages of an attendant from each shift.

Of course, it was cheaper to locate the valves at the upper end of the pipe line than at the power house, as in the former case the working pressure is only 87 lbs. per sq. in., while in the latter case it would have been 225 lbs. per sq. in., a very high pressure for valves of this size.

Regarding the thrust bearings, these are of the oil-pressure type. That is, the weight of the revolving parts of the unit is supported by oil pressure acting between two disks, one stationary, the other attached to the main shaft.

Mr. FAST.—I would like to ask if any particulars regarding the design of the turbines, the angles of the vanes and buckets, &c., are available?

Mr. RUST.—The wheels run at 400 revolutions per minute. The specific speed in English units is about 21. I am sorry the other features regarding the design are not available. They could only be obtained from the manufacturer.

Mr. DONNELLY.—What is the prospect of the use of any considerable amount of current by the railroads, especially on the main line passing over the mountains? I presume you could supply them with such power as they required.

Mr. RUST.—There seems to be some prospect of this. I understand the Southern Pacific intend to electrify their suburban lines around San Francisco, and that they have had estimates made of the cost of electrifying the main line across the mountains. We could supply them with power by extending the power house and installing additional units.

BROOKLYN ENGINEERS' CLUB.

No. 101.

THE PAVEMENT REPAIR PROBLEM OF THE BOROUGH OF MANHATTAN.

BY DANIEL B. GOODSILL, MEM. B. E. C.

PRESENTED FEBRUARY 9, 1911.

Before presenting to you some aspects of the Pavement Problem in the Borough of Manhattan, a brief resumé of the machinery of administration by which the work is accomplished may not be out of place, as indicating that the work of maintaining the pavements is due, in a measure, to it. The departmental routine is slow and cumbersome, but contains effective checks on dishonesty and graft. For instance, in order to effect the laying of a pavement in an unpaved street, it is necessary for property owners to petition the Board of Local Improvements of the district in which it lies, for that Board to approve it and notify the Board of Estimate of that fact, which Board thereupon authorizes the President of the Borough to contract for the work. An estimate and plan is then made by the Chief Engineer, the contract is advertised in the official and local press for ten days, the bids canvassed and contract awarded to the lowest bidder. It must then be registered by the Comptroller and duly executed by the City and contractor, if the sureties be approved by the Comptroller.

If the contract be a small one, say, of \$1 000.00 or more, it may readily be seen that the cost of clerical hire and engineering supervision will be a high per cent. of the contract cost, for up to this point high-salaried officials have had to do with it almost exclusively. This is what the City pays to ward off graft.

The time taken between the initial step of the Board of Local Improvements and the awarding of the contract, providing funds are available, is, for highway improvements, two months.

For the repavement of the City's streets, a fixed sum is apportioned each year to the Borough, and the President is authorized to make contracts up to this amount. Such procedure is as follows: The Chief Engineer of Highways is requested to furnish a list of those streets recommended to be paved, for the approval of the Borough President, who then directs that contracts forms be made and the contract advertised. Plans and estimates are made, the contract forms sent to the Law Department for approval, the work advertised and let as for the new work. The usual length of time taken for this process is about two months, and should the contract develop any irregularity—and they sometimes do—the procedure and wait must be

again endured by the engineer in charge of the work to be done. An experience of many years leads me to believe that there is no way of accelerating this tedious process—that the wheels of city government grind slowly and not too surely.

The Chief Engineer is governed in his selection of the streets to be paved and in his selection of the character of the material to be used, by the amount and kind of the vehicular traffic; by the character of the street, whether residential or otherwise; by petitions of civic associations and property owners, and by the cost of maintenance, if the pavement be asphalt. With the exception of the latter information, none of these are, however, presented in an exact manner, and I wish to emphasize the great and growing importance of traffic observation in our congested cities, for the purpose of making the pavement fit it. Too much haphazard guessing is done in this important matter, and the criticism has recently been made that we have, in Manhattan, our business streets paved with residential pavement, and the residential streets paved with a business street pavement. It needs only to be pointed out that, had systematic traffic censuses been taken to ascertain the rate of increase in the vehicular traffic, a different kind of pavement would have been laid had sufficient emphasis been given to this most important factor in determining the kind of pavement to be laid and the manner of constructing it. I say "most important," and believe it so, because of the constantly lessening importance of noise on account of the high buildings and from the fact that any well-constructed pavement is not now an offensive noise producer. It is again recognized when the economic side is considered. Why lay asphalt 2½ ins. thick, when 1½ ins. will last, say, ten years under a given traffic? Why lay 6 ins. of concrete when four would do, say, on our residential streets, where the traffic is found to be light, with a slow rate of increase?

The problem is perfectly simple. Due weight must, however, be given in deciding the kind of pavement to the presence of hospitals, public schools and those buildings of a quasi-public nature, but the main factor has been indicated. I have endeavored to obtain statistics as to street traffic in the Borough of Manhattan, and find that two censuses have been taken, one by General F. V. Greene, of which an account is given in the transactions of the American Society of Civil Engineers, Volume 15, page 123, 1885, "An Account of Some Observations of Street Traffic"; and one by Clifford Richardson, an account of which is given in the transactions of the American Society of Civil Engineers, Volume 57, page 181, 1906, "Street Traffic in New York City," and Major Howard, *Engineering News*, Nov. 7, 1907. General Greene gives the average tonnage of vehicles in 1885, at Fifth Avenue opposite the Worth Monument, as 0.68 tons; this was exclusive of

the weight of the horses. In 1904 this average had reached 1.64 tons, according to Clifford Richardson's census, and today is no doubt much higher, as is the total tonnage and number of vehicles. What this traffic is today, would make an interesting comparison with the two censuses mentioned.

The system of modern improved pavements in the Borough of Manhattan was instituted in 1890, and the maintenance periods of the contracts have expired, placing the burden of repair work on the City. Cost accounts have been kept, and since 1905 the cost has decreased, owing to careful supervision and elimination of the high cost streets by repavement, from 34 cents per sq. yd. per year to less than 12 cents. For the last two years accurate records of the amount of pavement laid in each street, with the date, have been kept and a careful comparison made to determine those streets where the cost of maintenance runs over about 25 cents per sq. yd. per year, and where this cost is likely to continue. In 1910 the area of those streets where the cost was more than 50 cents per sq. yd. per year was 24 786 sq. yds. The amount of traffic which these streets sustain, bears an important relation to the cost, and repavement of them should be considered in connection with it. The elimination of the high cost streets from repair contracts of the Borough of Manhattan, has been a large factor in producing a remarkable decrease in the cost of maintaining the streets where the guarantee has expired, to which allusion has been made. Yardage of this kind of pavement has increased since 1906 from 1 013 000 sq. yds. to 2 460 089 sq. yds., and the cost of maintenance, as previously stated, has decreased from 34 cents to 12 cents.

REPAIR WORK.

The area of sheet asphalt pavements maintained by the Borough in 1910, was 2 460 089 sq. yds., the entire amount of asphalt pavement in the city, both under and out of guarantee, being 5 230 484 sq. yds. This area is maintained by four principal companies, which operate in the city under contracts with it to the number of about 800. The companies referred to are the Barber Asphalt Paving Company, the Sicilian Asphalt Paving Company, Uvalde Asphalt Paving Company and the Asphalt Construction Company. The Barber Company has 3 plants, the Sicilian Company 1 plant, Uvalde Asphalt Company 3 plants (one of which is not operated), and the Asphalt Construction Company 1 plant. Seven of these plants laid, during the year 1910, about 1 250 000 sq. yds. of pavement in new and repair work. The Barber Asphalt Company has under guarantee about 1 500 000 sq. yds., considerably more than the other companies, and the bulk of work is, in consequence, done by it, most of the material coming from its plant in Jersey City. This company has plants on the

Harlem River, in the Borough of the Bronx, at the foot of 151st Street; at Varick and Stagg Streets, Brooklyn, and in Jersey City at the foot of Henderson Street. The plant in Jersey City is located on the water front, about $1\frac{1}{4}$ miles from the ferry, and the asphalt, broken stone, sand and other materials are supplied by lighter. The asphalt is refined at Maurer, N. J., about seventeen miles from Jersey City, and is sent from there in barrels by lighter to the plants. The sand is obtained from Perth Amboy and other places, and the broken stone from Nyack, N. Y. The plant contains the following machinery:

- 1 120 horse-power boiler,
- 1 100 horse-power engine,
- 1 Revolving sand screen,
- 1 Revolving stone screen,
- 2 sand drums,
- 2 Stone drums,
- 4 Asphalt melting tanks, 16 000 lbs. capacity each,
- 4 Dipping tanks,
 - Oil tanks of 27 000 gals. capacity,
- 1 Binder mixer, 16 cu. ft. capacity,
- 1 Asphalt mixer, 16 cu. ft. capacity.

About 1 200 cu. yds. each of sand and stone may be stored in bins, and the yard has ample area for additional storage for coal, wood, stone dust and street equipment and contains machine shop for plant repairs—an important adjunct. The force engaged in running the plant is as follows:

- 1 Day engineer,
 - 1 Day foreman,
 - 1 Night foreman,
 - 1 Machinist and general mechanic,
 - 1 Office clerk, recording materials used,
 - 1 Hoisting engineer (for materials brought in by boat),
 - 3 Machinists,
 - 1 Night watchman,
 - 1 Yard foreman,
 - 3 Coal passers,
 - 1 Tally clerk,
 - 1 Day watchman,
 - 42 Laborers,
- a total of 58 men.

The maximum capacity of this plant per day of eight hours is 500 boxes of top, each of 9 cu. ft.; or 900 boxes of binder, each of 9 cu. ft., or between

7 and 8 loads per hour of 5 boxes of 16 cu. ft. The plant is in operation nearly the whole year and often to its full capacity. The work starts at 5 A. M., and stops at 4 P. M. The cost of operating to its full capacity, exclusive of fixed charges and cost of material, is said to be about \$800.00 a week. This plant delivers asphalt pavement material to that part of the borough between the Battery and 59th St., the duration of the longest haul being about three hours; this, of course, include the ferry trip. The material is delivered in bottom dumping trucks, horse-drawn, and supplied by sub-contractor.

The street equipment of this company for laying the pavement, consists of gangs of 23 men, made up as follows:

- 2 Rakers,
- 2 Smoothers,
- 1 Roller engineer,
- 1 Night watchman,
- 1 Foreman,
- 2 Tamperers,
- 1 Roller attendant,
- 1 Day watchman,
- 11 Laborers,
- 1 Timekeeper.

The work of the gang is divided into two parts, that of cutting out, or preparatory work, and of laying. By this system the work of laying the material quickly follows that of cutting out, and, if bad weather occurs, the work may be stopped, leaving no holes unfilled. The company maintains a storage yard at No. 640 West 39th St., for its street equipment, and a machine shop in Long Island City, foot of 6th St., where the extensive repairs to street equipment are made. The plants located in the Bronx and Brooklyn Boroughs are somewhat better arranged and more modern than the Jersey City plant, and are of about the same capacity, and supply, when all the plants are working, that part of the Borough north of 59th St. (Bronx plant), and south of 59th St., east of Broadway (Brooklyn plant.) These 3 plants have supplied material for laying 7100 sq. yds. of pavement in repairs in 1 day. The Bronx plant refines its own asphalt and supplies paving material to the Bronx, Mt. Vernon and adjacent districts, as far north as New Rochelle. It differs from the Jersey City plant in these particulars: Refines its own asphalt (4 refining tanks), and uses both Trinidad and Bermudez asphalt. It has 1 binder mixer of 9 cu. ft. capacity, and 1 top mixer of 16 cu. ft. Its maximum output is about 500 boxes of top per day of 8 hours, each box being 9 cu. ft., or about 8 loads per

hour of 81 cu. ft. are delivered. The yard has area for the storage, in bins, of 700 cu. yds. of stone, 1 400 cu. yds. of sand, and 350 tons of coal. There are 2 oil storage tanks, which contain 16 000 gals. each. The force employed is as follows:

2 Engineers	@ \$5 00 per day.
2 Foremen	@ 5 00 " "
1 Blacksmith	@ 4 00 " "
1 Blacksmith helper	@ 3 00 " "
1 Carpenter	@ 3 50 " "
1 Yard clerk	@ 3 00 " "
1 Hoisting engineer	@ 3 50 " "
1 Day watchman	@ 1 75 " "
1 Night watchman	@ 1 75 " "
32 Laborers	@ 1 75 " "
2 Yard foreman	@ 5 00 " "

Total 45 men.

The plant is not often run to its full capacity. It is headquarters for the company's asphalt block paving work, and materials and tools connected with this work are stored here. The Williamsburg plant is situated at Varick and Stagg Sts., at the head of Newtown Creek, Borough of Queens; it has the usual outfit of Corliss engine, 80 horse-power, 4 sand drums, 16 ft. x 30 ins., revolving stone and sand screens, 6 melting tanks, 15 000 lbs. capacity, oil tanks 35 000 gals. capacity. The top mixer is of 15 cu. ft. and the binder 9 cu. ft. capacity, and the maximum output of paving material is about 320 boxes of top or 640 boxes of binder, working 8 hours, or 10 loads of binder of 9 boxes each, 9 cu. ft.; or 9 loads of top each of 5 boxes of 15 cu. ft. There is storage for about 1 700 cu. yds. of stone and 1 200 of sand, and the yard contains the usual sheds for cement and stone dust and the machine shop. The refined asphalt is sent here from Maurer, N. J., and no refining is done. The force is as follows:

2 Engineers, night and day	@ \$5 00 per day.
2 Firemen, night and day	@ 3 50 " "
2 Watchmen	@ 2 00 " "
1 Fireman for tanks	@ 3 00 " "
2 Oilers	@ 2 25 " "
1 Coal passer	@ 2 50 " "
1 Hoisting engineer	@ 5 00 " "
2 Yard foremen	@ 5 00 " "
2 Clerks	@ 3 00 " "
42 Laborers	@ 1 75 " "

Total 57 men.

The Jersey City plant and Bronx plant have drums for heating old asphalt removed from the street. It is fed to a crusher and elevated to the top of the drum, which stands on end and is steam jacketed. The material is removed from the bottom of the drum and placed in a mixer, where asphalt cement is added, and the material used, where permitted, as a binder course. The repair work of this company is in charge of a superintendent who directs the locations of the gangs daily, after consultation with the City's Engineer, and he obtains his material from the three plants, as indicated, and as the necessity of the work requires. The foremen of the gangs report daily to him the material used and square yards of pavement laid; the latter being classified into pay work and the company's maintenance work on its streets under guarantee. The Barber Asphalt Paving Company has available for immediate use,

22 Rollers of 5 tons weight,

4 " " 3 " "

1 " " 8 " "

The plants of the Uvalde Asphalt Paving Company are situated at the foot of Greene St., Jersey City; at Grand and Varick Sts., Brooklyn, and at 157th St. and Harlem River, Manhattan. The latter plant has not been operated in some time, but is in good repair and could be at short notice. These plants are nearly uniform in design and are all kept in excellent repair. They turn out about 200 boxes of material in 8 hours, each box being 16 cu. ft. It is delivered almost exclusively in end dumping carts, which have been especially designed for the work. The roller outfit consists of 10 of 5 tons, and 1 of 10 tons. The street equipment and manner of working it is the same as that described for the Sicilian Asphalt Paving Company.

The Jersey City plant is housed in a building which has a steel framework covered with galvanized iron, and the entire plant is under cover, with the exception of the storage area for the sand, stone and asphalt. There are 4 sand and 2 stone drums, 95 horse-power Corliss engine, 150 horse-power boiler, top mixer 16 cu. ft., and binder same; oil tanks, 30 000 gals. The company has at its disposal about 45 trucks; 1 fireman, 1 engineer, 1 machinist, 1 foreman, 1 clerk and 30 laborers employed, make up a force of 35 men. Asphalt is refined and is agitated by air and dipped by hand. The dust collecting apparatus is complete and effective. The company claims to have laid 3 750 yds. of pavement, including binder, in 1 day. Eight loads of top and 10 loads of binder, is maximum output, or 80 to 100 loads per day.

The plants of the Barber Asphalt Paving Company and the Uvalde Asphalt Company, which are located in Williamsburg, on Newtown Creek, are

accessible by the Williamsburg Bridge, which places them within easy reach of the lower district in Manhattan.

The plant of the Sicilian Asphalt Paving Company is located on the north side of 54th St., near 12th Ave., at the water front. It is about 15 years old, is built of steel and is carefully and systematically arranged to occupy a small ground space. An upright engine drives 2 sand drums, 2 stone drums, elevator and machinery for making roofing material. Refining is done here and crude asphalt is brought in carts up an incline to the level of the stills. There are 2 mixers of 16 cu. ft. capacity each, 65 loads per day of 4 boxes; 16 cu. ft. each is about the maximum capacity. This, however, when end dumping wagons are used. If bottom dumping wagons be used, the output is increased as these take 5 boxes of 16 cu. ft. The company claims that it can lay 2 500 sq. yds. of finished asphalt pavement a day, using its maximum output. It confines its operations to that part of the city below 100th St., and is not troubled by long hauls, that to Maiden Lane being its longest and the duration of it about two hours. The carts used are of the end dumping variety largely, only about one-third being of the bottom dumping style and these are used on new work. The composition of the street force is about the same as that described as being used by the Barber Asphalt Company, but the cutting out of the pavement is followed by the laying and they do not proceed simultaneously as with the beforementioned company. Its roller outfit, available for immediate use, is

2 2½-ton Rollers,
5 5 " "
1 13 " "

They are of the tandem "Pioneer" type. Blacksmithing and light repairs are done at this plant.

The plant of the Asphalt Construction Company is located at 137th St. and Harlem River, and is a modern plant in every particular. It has 2 large sand drums, sizes 21 ft. x 48 ins., 4 melting tanks, oil tanks of 27 000 gals. capacity, and its mixers are 2 in number, the top having 16 cu. ft. capacity and the binder 13 cu. ft. capacity. There is storage in the yard for 700 cu. yds. of stone and 700 cu. yds. of sand. Owing to this small storage capacity, in the busy time it is necessary that boats should always be at the dock in the course of unloading. The company uses Bermudez and California asphalt. The plant is run by a 125 horse-power Corliss engine, steam for which is supplied by a 150 horse-power boiler. The dust collecting apparatus is a feature of this plant and makes it cleanly and convenient and agreeable to work in. The roller outfit, available for immediate use, is

1 3-ton Roller,
1 7 " "
1 11 " "

The maximum output of pavement material is about 88 loads of 5 boxes, each of 16 cu. ft. per day, or 144 boxes of top, each of 14 cu. ft., and 244 boxes of binder, each of 13 cu. ft. The estimated cost of running the plant, exclusive of pavement material used, is stated to be \$85 00 per day.

The Borough organization for the recording of pavement defects consists of a division of the city into six districts, each in charge of a Chief Inspector, under whom are four to six division inspectors who patrol the streets and record all holes, openings or other defects in the asphalt pavement. Asphalt contractors are sent copies of these records and are directed to do the work indicated. Should they fail, special reports are made to the Assistant Engineer in charge, who initiates steps to carry out the work as provided by the contracts.

Difficulties in carrying out the work in accordance with the contract provisions, which require a continuous maintenance of the pavement in good repair, are the large number of street openings and the consequent confusion as to ownership and responsibility for pavement damage, interference with the repair work due to congested traffic conditions making it slow and requiring it to be done over, and the sudden accumulation of work due to unfavorable weather conditions. During the Winter, when snow and ice and low temperature prevail, rollers are difficult to move and slide easily on the slippery pavements, nor can they be stored, except temporarily, on the streets, because of frequent objections of property owners. Materials are difficult to move from plant to street; ferries are delayed, and sand and stone at plant are wet or frozen. Less work is gotten from the men and tools are apt to be too hot. The holes are likely to be filled with snow and mud, even though the adjacent pavement be dry, and in addition there is the uncertainty of the weather conditions. During the suspension of repairs the traffic continues and is highly destructive in the wet and cold periods, and results in pavement conditions of which loud complaint is made by the public. The table of repairs made to those streets out of guarantee shows how few working days there were in the Winter months, and that a normal condition of the pavements did not ensue till May.

In conclusion I would point out the following solution of some of the difficulties in obtaining good asphalt pavements. A number of central repair stations, say 12, to be established at convenient points, so that materials could be obtained without the necessity for long hauls and for the storage of rollers. These stations could be used for all kinds of light repairs. The establishment of, say, three asphalt plants on Manhattan Island, at convenient points, the city to furnish the asphalt, sand, stone, dust and other materials connected with the making of the pavement material, and contract for the labor of laying it. The material and manner of putting it together

should be given careful inspection at the plant and not on the street. End dumping carts to be used exclusively on the repair work and where combination loads of asphalt and binder are sent to the street, these materials to be separated by heavy canvas. Due importance should be given in the specifications and inspection, to the quality of the sand used, to insure its uniformity and conformity in the repair work to the pavement already on the street. On our narrow streets, congested with travel, repairs should be made at night with the use of artificial light. Traffic censuses at regular intervals should be taken and a change of character of the pavement made, should a more durable and cheaper material than asphalt be found, and to ensure an asphalt mixture suited to the conditions. That asphalt is the pavement above all others today, there can be no question. That, with the improved methods of construction and a systematic method of repair, it will be the pavement of the future—because the materials are easily obtained—is the firm conviction of the speaker. That the permanent economical solution of keeping the pavements of all kinds in good repair, under the very heavy traffic of the Borough of Manhattan, is to be obtained by revising the present system of working the repairs in preference to looking for a more durable material (which would necessarily be more slippery), for the street surface, is the opinion of the speaker.

February 9, 1911.

STATEMENT OF THE APPROXIMATE CAPACITIES OF THE DIFFERENT ASPHALT PLANTS OPERATING IN MANHATTAN BOROUGH, CITY OF NEW YORK.

Barber Asphalt Paving Company.

		Sq. Yds. Pavement per day.
Jersey City	4 500 cu. ft.	
Bronx	4 500 “ “	
Williamsburg	4 800 “ “	
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Total	13 800 “ “	7 500

Sicilian Asphalt Paving Company.

54th St. and 12th Ave.....	4 160 cu. ft.	2 500
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Uvalde Asphalt Paving Company.

Jersey City	3 200 cu. ft.	
Williamsburg	3 200 “ “	
Harlem	3 200 “ “	
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Total	9 400 “ “	7 250

Asphalt Construction Company.

Madison Ave. and 137th St. 5 000 cu. ft. 2 500

Total output 19 750

January 25, 1911.

CITY OF NEW YORK,

BOROUGH OF MANHATTAN,

BUREAU OF LICENSES.

Number of licenses issued for vehicles, 1910:

3 446 Horses and wagons (Pedlers)
 3 588 Push carts "
 2 990 Express wagons
 11 763 Public trucks
 843 Dirt carts
 1 997 Junk carts
 1 605 Special funeral coaches
 1 037 Hacks (seat three or over)
 273 Special cabs (seat two)
 568 Hack cabs
 60 Stage coaches

Total, 28 170

It is probable that there are 100 000 or more vehicles on the streets of the borough. This table does not include automobiles.

February 1, 1911.

CITY OF NEW YORK,

BOROUGH OF MANHATTAN.

Area of Sheet Asphalt Pavement out of Guarantee and Entire
 Area of Asphalt Paved Streets.

Year	Out of Guarantee Sq. Yds.	Entire Area Sq. Yds.
1906	1 073 000	5 004 329.8
1907	1 001 892	5 038 258.8
1908	1 747 950	5 121 619.0
1909	2 168 010	5 229 023.0
1910	2 460 089	5 230 484.0

February 1, 1911.

CITY OF NEW YORK,

BOROUGH OF MANHATTAN.

Table showing working days in each month during 1910, the average number of gangs per day and the amount of pavement laid on those streets out of guarantee.

Month.	Working Days.	Gangs Per Day.	Amount of Pavement Laid, Sq. Yds.
January	12	10
February	16	20	20 600
March	24	29	63 463
April	22	24	46 294
May	21	23	15 796
June	24	21	20 788
July	25	16	16 487
August	25	20	33 039
September	24	18	26 903
October	25	16	23 060
November	23	23	48 000
December	13	15	5 613
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Total	254		320 043

January 1, 1911.

CITY OF NEW YORK,

BOROUGH OF MANHATTAN.

Mileage and Yardage of Paved Streets.

	Miles.	Sq. Yds.
Sheet asphalt	260.59	5 230 484
Asphalt blocks	52.99	1 279 310
Granite blocks	86.98	1 925 550
Wooden blocks	14.30	307 536
*Old stone	22.11	424 301
Macadam	4.63	112 712
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Total	441.60	9 279 893

*Includes Belgian block, trap rock and cobble.

Approximate Amount of Sheet Asphalt Pavement Laid in the Borough of
Manhattan in 1910.

	Sq. Yds.
Barber Asphalt Paving Company.....	988 000
Asphalt Construction Company	78 000
Sicilian Asphalt Paving Company	125 000
Uvalde Asphalt Company	75 000
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Total	1 266 000

This is equivalent to 74.4 miles of street, thirty feet wide.

10.4 miles of new streets were laid, leaving 60 miles of street, 30 feet wide, equivalent to the repairs.

The above information was obtained from the asphalt companies, and is an approximate estimate.

DISCUSSION.

Mr. PARFITT.—I would like to ask if asphalt blocks were not more approved for suburban streets than sheet asphalt, especially so as repairing would not be as expensive.

Mr. GOODSELL.—I quite agree with you that asphalt blocks are suited to suburban streets. Of course, they do not require any special plant, and can be laid by ordinary labor which may be obtained anywhere, and so the work can be done quite economically. There is to be considered the original cost as well as the cost of laying. You lay with the blocks a wearing surface that is 3 in. thick, and you can make asphalt wearing surface 1 in. or 1½ in. That is a considerable economy.

Mr. PARFITT.—The suburban streets are being continually repaired, taken up for purposes of improvements, water mains, sewer connections, etc.

Mr. GOODSELL.—That is quite true of the pavements in Manhattan also.

Mr. PARFITT.—Have you had any thought in the matter of cheaper method of laying street pavement in suburbs where there is little traffic? Would the suggestion to reduce the width of the roadbed be considered?

Mr. GOODSELL.—I should say that could be easily done. Macadam pavements throughout the State and throughout Massachusetts are not laid full width of the street. They have taken some standard width, usually 16 ft., which is just about enough to allow two wagons to pass.

Mr. PARFITT.—Do you think that if a certain movement were started that it would meet with favor with the city officials? A. I certainly do.

Mr. PARFITT.—I would refer that to the Committee of Congestion as to cheapening the method of street making in suburbs. People go out and build, and are promised streets at a small expense.

Mr. GOODSELL.—Some form of asphalt macadam which has been studied a great deal seems to meet the situation there.

Mr. PARFITT.—How much cheaper?

Mr. GOODSELL.—I could not say, but very probably cheaper; possibly 2/3 cheaper.

Mr. SOMNER.—Is it not true that the city effects considerable saving in the work necessary to be done in cleaning sewers after the street is laid, which would not be if the streets were laid in accordance with methods spoken of by Mr. Parfitt. As the street has dirt below, as soon as you pave them with asphalt that sewer cleaning is done away with, and it strikes me that the saving on amount of work necessary to be done in the Sewer Department would be quite a considerable item.

Mr. GOODSSELL.—I think that is quite true. I believe that some form of monolithic pavement undoubtedly would economize in more than one way, not only in sewers and in street cleaning, but in various other ways.

Mr. SOMNER.—Is the liquid asphalt you refer to that system of road oiling?

Mr. GOODSSELL.—Yes; the laying of macadam by the penetration method. The oil or asphalt is sprinkled over broken stone and forced down, and over that is spread smaller broken stone, which is in turn rolled, and possibly another coat, depending on the character of the road, and then the whole thing is rolled, making a good hard road.

Mr. SOMNER.—I saw considerable work done up the State, up through the neighborhood of Hunter; the ground seems to make an excellent road there.

Mr. GOODSSELL.—The oils have been laid by the State Highway Commission.

Mr. OESTREICH.—Did I understand you to say that the asphalt pavement is best? Do you mean sheet asphalt? Asphalt block laid on concrete base and clean sand between the blocks is a far superior pavement for a residence street. For any street that has a grade up to $1\frac{1}{2}\%$, it is much better for the horses, and after rain it is much less slippery, and especially the method of street cleaning in New York City seems to show that way.

Mr. GOODSSELL.—Well, I think all that depends on the service the pavement is to give. I said that I thought the asphalt pavement was the pavement of the day. By that I mean the pavement most used and probably that most in demand. The asphalt block is undoubtedly the less slippery of the two pavements, because it has joints and can hold the corks of the horses' feet and so prevent slipping. It has small stone in it which makes it different from the asphalt pavement which is made entirely of sand. The wearing surface is no doubt good because of the presence of the stone, and it has the additional value of being easily laid because the labor can be gotten anywhere, but sheet asphalt is much cheaper. These asphalt plants are not complicated affairs. They are things that can be easily run by anybody after a little experience, and the quality of the work turned out will be sufficiently good for the residential and locally traveled streets.

Mr. VAN BUSSEM.—In view of the heavy cost of asphalt repairs, would not asphalt block pavement be more economical in the end?

Mr. GOODSSELL.—I think not. The cost of repairs is not so great as you seem to think. The last contract price in Manhattan was 97c. per square yard. Last year we laid pavement for 77c. Of course, that is probably above the cost of laying it, but not a great deal. I should estimate that the cost of laying asphalt pavement under the repair contract which we have in Manhattan would probably be from 60 to 65c. a yard, and the asphalt block repairs will certainly cost more than that.

Mr. VAN BUSSEM.—That sheet asphalt that you mention for 77c., that is not as durable as asphalt block?

Mr. GOODSSELL.—No; probably not.

Mr. VAN BUSSEM.—I think that it is not so costly to maintain the asphalt block as it is the sheet asphalt.

Mr. GOODSSELL.—But you must take into account you are laying 3 in. of material against 2 in.; that the cost of manufacture of asphalt block is higher, and also the blocks deteriorate very rapidly after reaching a worn condition. They are very good for the first three years or so, and the water seems to affect them after about that time, and they go very rapidly and the traffic irons them out.

Mr. VAN BUSSEM.—How does the 2-in. asphalt block compare with the 2-in. asphalt?

Mr. GOODSSELL.—The cost of repairing those streets in Manhattan on which the original guarantee of maintenance has expired in the asphalt block paved streets is about the same as that of the sheet asphalt; very little difference.

Mr. VAN BUSSEM.—You mention on those slides that the cost of maintenance is about 11c. A. Yes.

Mr. VAN BUSSEM.—Do you include in that the entire area of Manhattan of the asphalt pavements; that is, the actual repairs; that is, the good and the bad, or, in other words, the entire area of pavement under maintenance?

Mr. GOODSSELL.—The entire area maintained is that where the original guarantee of maintenance has expired. It does not include those streets where the original guarantee of the contract is in force. The cost of repairing those kinds of streets we have no means of knowing. It has been estimated at from 10c. to 15c. per sq. yd.

Mr. VAN BUSSEM.—That 11c. does not show the cost of actual repair?

Mr. GOODSSELL.—I don't quite understand.

Mr. VAN BUSSEM.—I mean this: You speak of the entire area of pavement—that is, pavement to be repaired and also pavement that is in good order—that includes all of it. I speak of the actual repair.

Mr. GOODSSELL.—The actual repair. I could ascertain that. I have not done so. We laid 320 000 yds. of pavement last year at a cost of about \$300 000, or less than \$1 00 a yd.

Mr. PARFITT.—Another means of eliminating the repair account would be in the suburbs to lay a sewer in the center of the streets, and provide parallel sewers with connections, and that sewer to be laid in the space allowed for sidewalks. If the street was reduced in width the roadbed can be laid at that width. That would do away with all connections every 600 or 300 ft. on each side of the street. Same way with the water. Instead of making connections directly with larger sewer in the center of the street, would connect with the smaller pipe.

Mr. CUOZZO.—Do you think the settlement of asphalt pavement is more or less due to the concrete base underneath settling or breaking, or is it due to the quality of sheet asphalt on top? Some seem to think it is due to the wearing off of the surface material. I noticed this particularly on 9th Ave., from Union St. up 9th Ave., which was paved five or six years ago, and

it shows a very uneven settlement, and it occurred to me that it was due to the quality of making and placing on an uneven base.

Mr. GOODSSELL.—Of course, the matter of back filling trenches over sub-surface structures is of great importance, and is a thing that should have more attention by the city to insure that even surface of pavement which is desirable. I should refer you to Mr. Schmidt. I know the conditions in Manhattan. The sub-surface structures are very complicated in Manhattan. Each company has practically put its pipes and sub-surface conduits wherever it pleased, and has placed them without control or direction from the city, and the result has been a great mass of pipes in the street which, when openings are made, necessitate tunneling. You have a subway conduit along the gutter; you have your sewer or water pipe in the middle of the street. In order to make a connection with the sewer or water pipe you have to tunnel underneath the conduit.

Mr. CUOZZO.—I don't mean where you tear up the street for purpose of putting in connections general with asphalt pavement. A good deal has to do with the concrete base, it seems to me. The sub-surface has not been evenly rolled. That is observed in a good many places. I have seen it where there is not a great deal of travel. In Jerome Ave. some places are worn out. I want to know whether it is the base or wearing surface. I believe if it is the concrete base at fault, a good deal of repair in that class would be eliminated by putting in dry concrete and immediately following it with roller.

Mr. GOODSSELL.—I have only to say that good work is absolutely essential to produce perfect pavement. The concrete base must be carefully constructed of the right proportions and proper thickness, the binder laid and tamped and rolled and the asphalt surface on that. If there is defective work in any one of these three things that go to make up pavement, you are bound to have trouble. Of course, the main trouble, and what I believe to be the main cause of settlement, is in the filling underneath the foundation, and this should be thoroughly consolidated.

Mr. WILLIAMS.—Do you think that brick pavement is a success?

Mr. GOODSSELL.—We do not consider that it is suitable to the very heavy traffic which the narrow streets of Manhattan have to sustain. Brick pavements have been laid very successfully in the West; they have not been laid in Manhattan for the reason that they would not withstand the very heavy traffic.

Mr. HEGHINIAN.—Does the block pavement cost more than the sheet asphalt pavement?

Mr. GOODSSELL.—Comparing asphalt block pavement with sheet asphalt pavement, you have the same base which costs the same for both kinds of pavement, but when you come to the wearing surface, you have a thickness of 3 in. of the block against 1½ in. or 2 in. of the sheet asphalt, and adding the difference in thickness to the wearing surface makes a great difference in cost.

Mr. HEGHINIAN.—Is not the binder 1 and 2?

Mr. GOODSSELL.—The binder is very cheap to make; it is practically the cost of materials only.

Mr. HEGHINIAN.—The most expensive article in paving is the asphalt itself?

Mr. GOODSSELL.—The most expensive part of the cost of sheet asphalt is the sand and broken stone. Take a sheet asphalt pavement, the percentage of asphalt in any given unit is about 10 or 12%, the rest is sand; so it is the sand that costs.

Mr. HEGHINIAN.—One yard of sand is about 60c. and 1 ft. of sheet asphalt cost 9c.; asphalt blocks contains 5 to 8; asphalt blocks contains 1/3 less asphalt, and when I figure the itemized cost, you will see that the asphalt is the most expensive item in the whole make up.

Mr. GOODSSELL.—I should say the stone was. The asphalt block undoubtedly cost more on the street than the sheet asphalt.

Mr. HEGHINIAN.—I should like to find out why?

Mr. GOODSSELL.—One of the reasons is that the asphalt block is made with very expensive machinery, and in a very expensive way.

Mr. HEGHINIAN.—Sheet asphalt plants are limited in their use to certain number of months; asphalt block plants can be used the entire year.

Mr. GOODSSELL.—That is true under present conditions, but asphalt plants could be easily built to operate throughout the whole year and pavement could be laid throughout the whole year.

Mr. MESSENGER.—Have you done any re-surfacing of entire width from curb to curb in any old streets; if so, what was the cost per square yard?

Mr. GOODSSELL.—No, we never have done anything of that kind in Manhattan. We have been opposed to the method of repairing pavements with the use of surface heater. I believe with the Lutz type of heater that way of repairing the pavements could be economically done.

Mr. BURCHELL.—Don't you think it would be a better policy for the city to make it compulsory in the filling up to flush or flood with water to secure a better settlement of the cut before pavement is relaid? If that settlement could be prevented by flushing, would it not be better for the city to make it a compulsory matter?

Mr. GOODSSELL.—Well, that brings up the whole matter of back-filling trenches which, as I said, is a matter of very great importance. Whether the flushing of the back-fill would prevent shrinkage of all kinds of material that may be put back in a trench would seem to be doubtful. I believe that the ordinary way of tamping would be more effective than flushing.

Mr. VAN BUSSEM.—One of the slides showed the old materials in the yard. Did I understand that that was used again—old material taken from the streets?

Mr. GOODSSELL.—I understand that has been used to some extent.

Mr. HAMMER.—In all of the suburban places that I have ever seen, I have never seen asphalt pavement. Suburban places generally use macadam. In Flushing there is macadam road and that road is good as any, and they repair that twice a year—in the Spring and late Fall. And on the south side of Long Island the roads of the L. I. A. Club there is a 6-in. macadam. It is oil about 4 in. on a 2-in. dirt and screenings and then rolled. Any good development company in operating will make all house connections and lay all pipes so as to avoid breaking up of roadway, except where there is a break in the pipe.

Mr. CHEVALIER.—I would like to say something about sub-surface structures. I have no doubt if precautions are taken settlement over water mains and trenches could be avoided. In taking up the pavements no greater cut is made than is absolutely necessary, and when streets are advertised for new pavement the Electric Light Co. always looks into the question of existing facilities on that street, and every provision is made for future, and when connections are made service boxes are built which seems to be most economical in addition to pavement, and depends entirely on the character and cost of the pavement in the street, but, of course, in the present development of buildings in New York City it is almost impossible for any mortal person to see very far in the future.

Mr. DUNPHE.—How do the pavements of today compare with the pavements 15 or 20 years ago?

Mr. GOODSSELL.—Well, that is a pretty hard question to answer. I believe the Bermudez asphalt which is being used today is superior to the old Trinidad. We know from laboratory tests that it resists the water very much better, and I believe the pavements of today are much better, but one of the most important constituents of the asphalt pavement is the sand. I believe that you can make a good asphalt pavement with a poor grade of asphalt. It is just like making concrete. You have got to have a minimum number of voids, and each particle of sand in the asphalt surface has to be completely coated and adhere to its adjacent particle and the sand so graded as to have a minimum number of voids. The quality of your asphalt pavement is dependent very largely on the size and grading of the sand. So it is a pretty hard matter to say that the pavements of today are any better than 15 years ago. I believe it can be made very much better.

Mr. DUNPHE.—Why is it that repairs are necessary so often in certain places? I know various blocks where repairing is going on all the time. It is repaired and then disintegrates very much. Is that due to the quality of the asphalt?

Mr. GOODSSELL.—It is due to a variety of reasons. I think I mentioned in my paper, for instance, the desirability of having end dumping trucks over bottom dumping trucks. The idea is, for instance, that a load of asphalt may be dumped in a particular place where it is going to be laid, and in the dumping it may be solidified by compression, so that when it is all raked over to the 2 in. depth there may be some places more solid in the batch. The result is that the place where there is the least compression wears away first and leaves a hollow. The asphalt should be dumped away from the place where it is to be used and placed gently and evenly so as to get a perfectly homogeneous mass. Another reason is that there may be such a quality of sand used in certain parts of the mixture as to make in the surface a soft spot, which, when wheels pass over it, is readily marked and eventually cut into.

Mr. PRESIDENT.—Mr. Parfitt, about the laying of pipes you mentioned; did you mean that one set of pipes should be laid on one side of the street?

Mr. PARFITT.—I mean to put them parallel on each side of the street with the sewer, and in that way have the pipes run parallel with the

main sewer and main water line and then connections could be made from the smaller pipe to the houses.

Mr. PRESIDENT.—Would pavement like that of broken stone be considered assessed against the property as permanent pavement?

Mr. GOODSELL.—It would be in Manhattan.

BROOKLYN ENGINEERS' CLUB.

No. 102.

LATE IDEAS ON VENTILATION

BY W. W. MACON, MEM. B. E. C.

PRESENTED MARCH 9, 1911.

The word ventilation has generally signified an effort to maintain in building interiors a condition of atmosphere approaching as closely as practicable the normal condition of outdoor air. Sometimes the idea has been to introduce as much air as the circumstances admit to displace the more or less vitiated air, but sometimes the problem has been regarded solely as one of dilution, the incoming supply being depended on to bring about rapid diffusion and, in that way, constantly to dilute the air fully as much as to displace it.

In short, purity of air has been regarded as the important thing and yet we are face to face with complaints that edifices seemingly well ventilated from this standpoint are nevertheless not what the laymen feel they should be. It is recognized, of course, that the personal equation of different individuals has very much to do with the case. It is recognized also that ventilating apparatus is commonly in the hands of indifferent caretakers. It is recognized also that often the expenses of running an institution are subject to paring and one of the first departments to suffer is the ventilating installation.

It is probable that notwithstanding the numerous charges that the ventilating engineer's work is not altogether satisfactory, little serious attention would be paid to the objections made were it not for the fact that the open air schools, inaugurated through the effort of fresh-air exponents, have shown remarkable results. While there is evidence that some of the attempts to subject school children to unwarmed outside air in severe weather have been hazardous, the preponderance of the experiences indicates highly promising possibilities. Acknowledging that the pure air delivered by the modern school ventilating system has apparently reproduced closely outside air conditions, the assumption is that there is something of which we do not know, and so numbers have been attempting to discover what is the elusive feature differentiating the open-air school room from the closed ventilated school room.

HITHERTO ACCEPTED BASIS OF VENTILATION.

It is proper to say that the present practice of the ventilating engineer is based on the hitherto accepted claims of the physician and physiologist that the products of respiration of the animal are prejudicial to health and

with the carbon dioxide expelled by the body there are always concomitant impurities which are the really dangerous constituents of expired air. The result has been that efficacy of a ventilating plant has normally been measured in terms of the presence of carbon dioxide in the general ventilated place. It has commonly been assumed, as result of experiments, that the average person gives off about 0.6 cu. ft. of carbon dioxide in one hour. It is obviously a mere mathematical calculation to discover how much outdoor air should be taken in with its normal amount of carbon dioxide, so that each cubic foot of this air on receiving its quota of the carbon dioxide from the body will not contain too much carbon dioxide, and therefore not too many other supposedly dangerous properties. For example, if we supply 1 500 cu. ft. of air per hour to the individual and we assume that the individual delivers 0.6 cu. ft. of carbon dioxide per hour, each cubic foot of the air will increase its burden of carbon dioxide to an amount equal to $0.6 \div 1\,500 = 0.0004$ cu. ft. carbon dioxide. Outside atmospheric air is normally regarded as having 4 parts carbon dioxide in 10 000 parts, so that on the average each cubic foot of air will contain about 8 parts after it has taken up the carbon dioxide from the human body.

This method of regarding the ventilating problem seems not in the light of late investigations by physiologists to be the rational way. Ventilation has, of course, been provided in considerably larger volumes than the figures stated, perhaps as high as 6 000 cu. ft. per person, so that the average portion of carbon dioxide is brought very closely to the amount of outdoor air. There are conditions of occupation wherein the individual output of carbon dioxide is greater than 0.6 cu. ft. per hour and under such conditions either the amount of air must be greater or the approximation to outdoor air purity from the chemical standpoint is not so closely reached. Meanwhile the ventilating engineer is deserving of credit for the numerous installations demanding these large volumes of air and in which the air supply has been provided with a minimum cost, all other conditions being considered, and with the absence of or a minimum evidence of draft.

CROWD POISON NON-EXISTENT.

The foregoing is a brief statement of conditions relating to the basis on which a great deal of the modern ventilating work is being done. Of late years, particularly abroad, physiologists have been experimenting with the living person to ascertain the effect of different foods and of the air upon the metabolism or maintenance of cell building in the body, if that is the explanation the layman may safely make. These experiments have shown that there is no poison in the human breath and it thus appears that we were created not with a capacity to be mutually dangerous to one another in a confined chamber.

The vapors from breath have been condensed and injected into guinea pigs, white rats and other animals without any effect observable whatever. The living subject of experiments has been left for days at a time in chambers with little or no ventilation and the ill effects have been attributed altogether to an increase of temperature and an increase in the humidity. Not only are no poisons delivered to the air but the body possesses automatic respiratory apparatus by means of which the proper amount of oxygen is taken into the body when the percentage of oxygen is as low as 15 or 16%.

An artificial movement of air such as obtainable by the use of the electrically-driven fan of the desk type, has immediately relieved the subject up to that time in considerable discomfort. It will not be feasible to report at any length the details of these various experiments, and at any rate the object of this contribution is rather to take official recognition of the new ideas developing, with the belief that before long something of an even more definite nature will be available for the engineering world than is at present the case. Mention may be made of one document readily obtainable. This gives the details of some experiments made at Wesleyan University, Middletown, Conn., by F. G. Benedict, Ph.D., and R. D. Milner, Ph.B., in Bulletin 175 of the Department of Agriculture, entitled "Experiments on the Metabolism of Matter and Energy in the Human Body," and obtainable for a nominal sum from the Government Printing Office, Washington, D. C.

The experiments have, of course, very much to do with the energy transformations taking place with the use of foods of different classes and calorific value and the like, requiring a study of the oxygen involved in the upkeep of the tissue building and work done and an account of the carbon dioxide and waste emanations from the body. About 25 of the 335 pages of the book are devoted specifically to ventilation.

For the study of ventilation in the Middletown experiments, a chamber 7 x 6 ft. in plan and 4½ ft. high was employed. To have provided an air supply of say 3 000 cu. ft. of fresh air per hour in accordance with some of the standards established—for example, by Pettenkofer—would have required a complete change of air about every four minutes, a condition which would have been impracticable. During preliminary experimenting for the other phases of the general problem, it was found that persons could remain several hours in the air-tight chamber with no air passing through it and experiencing no special discomfort other than that produced by the rise in temperature. When a cooling system was introduced to keep the temperature comfortable, the absence of ventilation was not noticeable for several hours longer.

For ventilation, an air-pump was employed to draw air through the room. In the case of the first subject experimented with, about 3½ cu. ft. of air

were supplied per minute. The subject did not realize the nature of the test and slept with his accustomed regularity and no abnormal condition of any kind developed. In this case the test was continued for $2\frac{1}{2}$ days and the subject's health was not only excellent when he came out, but it continued so. Another experiment was carried on with a different subject, but the amount of air was reduced one-quarter without his knowing it, so that he did not get much over 2.6 cu. ft. of air per minute as compared with 30, 40 and 50 cu. ft. sometimes demanded and provided in modern ventilating plants. This subject at the end of five days was perfectly well and ready to repeat the experiment.

A fourth experiment of 12 days' duration was made and here the ventilation was less than 2 cu. ft. of air per minute. One of the subjects was an athlete and during the experiment in the chamber rode eight hours a day on a stationary bicycle ergometer. The work was done in series of two hours each, relieved with short rests. The carbon dioxide production reached its maximum during the work and was 183 volumes in 10 000. On opening the window in the chamber after an experiment the air invariably smelled close to an outsider, but it was unnoticed by the subject himself. In some of the other experiments the amount of carbon dioxide was 35 to 37 parts in 10 000, or about 12 times the normal proportion of good outdoor air, and at the end of the work period the amount of carbon dioxide corresponded to 231 parts per 10 000 or 80 times the normal. For 12 hours in each work day the subject lived in general in air with an average carbon dioxide content amounting to considerably over 100 parts per 10 000 or 33 times the normal outdoor condition.

IMPORTANCE OF AIR IN MOTION.

The specific findings of the Middletown experiments indicate that an increase in the amount of carbon dioxide is absolutely without effect on the mental and bodily comfort of the subject, that the so-called concomitant impurities are not discovered; that the subjects complained of headache or other discomfort at no time. Other experiments might be mentioned, like some at the University of Minnesota, with a bull in practically an air-tight stall for a period of 37 days and enjoying a gain in weight of 1 lb. per day during the entire period and of an interesting experiment made by Dr. Leonard Hill of the London County Medical Hospital, London, England. Dr. Hill put 8 students in an air-tight chamber of 106 cu. ft. capacity. The subjects naturally entered in somewhat excited spirits and for half an hour they were kept without access to the outside air. As time went on they became uncomfortable, the wet bulb thermometer crept up to 80° , the air became depleted of its oxygen and the carbon dioxide percentage rose. An electrically-driven fan had been provided in the chamber and the next stage

of the experiment was to run the fan, when it was found that although the students were still breathing the stale air in the cabinet and no other, the discomfort was reduced so materially that the impurities in the confined atmosphere had little effect on the breathing, while the temperature registered by the wet bulb was lowered. The experiments were repeated with two persons, and by means of an electric heater the wet bulb temperature was run up to 85°, and at certain stages definite quantities of carbon dioxide were introduced. Deep breathing had to be resorted to in this case, and the pulse was high, but all the discomforts were instantly suspended when the fan was whirled and there were no after symptoms such as headache and lassitude. There are instances where the amount of carbon dioxide was carried as high as 400 parts or 4% of the atmosphere.

WHY AN AIR SUPPLY IS STILL IMPORTANT.

The general findings of all these experiments briefly referred to are that what is of the leading consideration, of the greatest importance to the upkeep of the health of the human body, is that the body shall not be subjected to too high temperature, that it shall not suffer too high humidity and that it shall experience gentle air movements or air agitation. Under certain conditions a continuous supply of air will prevent the high humidity, and, of course, the high temperature, when it is otherwise not easy to reduce the temperature. It is not, however, essential to have an incoming supply of air to get the gentle air currents seemingly necessary, and at first blush one might assume that all that is needed is to install electrically-driven fans or employ Hindustani punka wielders. It should be remembered, however, that these experiments are referring chiefly to the moderately healthy individual. They do not provide for the assemblage in which there may be a number of persons infected with one of the impure air diseases, such as tuberculosis, pneumonia or influenza. Means for minimizing contagion put a premium on the desirability of flushing the building interior with a continuous supply of air, but even in this case there are other considerations.

AIR IN CONTACT WITH THE BODY.

The fact that the movement of air across the body has proved so efficacious is an indication that it is not only the air one breathes that has much to do with his health but the air surrounding his body. It appears that the value of ventilation is not solely to minimize the danger of disease propagation but also to provide the utmost facility for favoring the heat exchanges of the body. High relative humidity has long been regarded as undesirable in limiting evaporation from the skin and as interfering with the proper dissipation of heat from the body or heat balance. Everyone

knows the exhilaration of the steamship ride or the sojourn at the seashore, where one is breeze-swept. One's clothing tends to hold an envelope of air near the skin and if conditions are not present allowing for the flushing of the air envelope, this relatively stagnant air approaches the temperature of the body and becomes saturated with moisture and in that way interferes with the emission of heat from the body.

It is probable that one reason why ventilating installations bringing about a constancy of temperature throughout the inhabited space and an absence of draft are regarded by self-appointed experts as stuffy is that the temperature is not sufficiently below the temperature of the air envelope around the body to start the natural or gravity circulation of air so that the cool room atmosphere may more or less continuously displace the air envelope. The result is discomfort, irritability and restlessness, so often observable in an audience.

Recognition of this phase of the subject has been made by some hospitals in New York. It is understood that alcoholic pneumonia patients in Bellevue hospital, for example, are now so far as possible placed on balconies and near open windows, so that there is an air movement across their beds with the result that instead of hypnotics being necessary, restlessness has been dispelled and the patients get needed sleep.

It is not to be expected that we shall in the early future educate the people in general to get used to gentle drafts. Other means will probably be necessary in order to give to a room a desired air freshness, so far as the layman's observation goes. It would seem feasible to supply at intervals air below the normal room temperature, for then we would not have the sameness of temperature throughout a room. The public wants fresh air and the ventilating engineer has been speaking of fresh air when he has been supplying pure air, or normal outdoor air. Fresh air, as the average man would define it, is cool air in more or less motion free from odor, so that if we can supply pure air not too warm, properly humidified, give it motion or the effect of motion and prevent odors so far as possible, we are supplying something calculated to maintain the upkeep of body tissue building and the equanimity of the victim's disposition.

DUST AND HUMIDITY.

There is a school which places a great deal of emphasis on the necessity of humidity regulation. It is a time-worn argument, though probably true and certainly reasonable, that dry air in contact with the membranes of the throat and respiratory passages tends to accelerate unduly the passage of moisture from the membranes. This has commonly been regarded as one of the chief causes of rendering the human body a victim of the impure air diseases. There is another school which considers that the question of

humidity is of secondary importance and that dust is far more to be feared. They do not put so much emphasis on the fact that dust is apt to be a bacteria carrier as that it is subject to a dry distillation with the production of irritating and poisonous gases and also that in cities it commonly contains injurious metallic constituents.

The author is indebted to W. P. Klobukowski, Ph.D., of Warsaw, Poland, for information of experiments he has conducted with the passage of dust over heated surfaces, where the temperature has not been great enough to bring about combustion to the extent of the formation of carbon dioxide. A distillation instead occurs with the production of doubtless some ammonia, perhaps carbon monoxide, and such compounds as acrolein, said to be decidedly irritating to the respiratory passages. Dr. Klobukowski is an exponent for introducing humidifying apparatus, where dust is unavoidable, so that each particle of dust, so to speak, is wrapped in an envelope of water vapor and is protected from the temperature which might bring about the distilling process.

Everyone is familiar with the characteristic odor from direct radiators when the heating system has not been operating for some time. Briefly the solution of the dust problems, aside from minimizing its introduction by air washers, filters and the like, and perhaps introducing the Japanese practice of removing the street shoes on entering the house, and the use of vacuum cleaning apparatus for removing the dust, is the use of substantially self-cleaning heating apparatus, in the case of direct radiators, for example, appliances not subjected to a temperature above 150° F., and probably never over 160 or 170°. In the case of direct radiators, this phase of the problem points to the desirability of smooth, plain surfaces and extended distances between sections of a radiator so that it is visible, and on that account will demand cleaning to keep it sightly. Ventilating systems should be designed for velocities preventing the deposit of the dust and with an absence of pockets where dust can collect at any time.

The other characteristic of dust on which emphasis has been placed is the fact that it carries with it minute metallic particles. It came as a shock when we read for the first time the result of the investigation of Dr. George A. Soper, of New York, that in the New York Subways one ton of iron dust was produced for every mile per month from the brake shoes alone. The author knows of one case where the dust separated by an air-washer was dried and when a magnet was applied to it, a considerable amount of iron particles was discovered. The point is made that these microscopic knives are not likely to treat the membranes of the respiratory passages in a tender fashion, and therefore, they assist in preparing the way for the pathogenic germ. As proof of the existence of metallic dust in

city air, Dr. Soper calls attention to the fact that marble buildings are gradually being stained by iron salts.

The question of odor seems to have its largest application in the fact that it is sometimes nauseating to some individuals and on that account tends to interfere with their proper physiological processes. The fact that air of respiration is not dangerous, as shown by different experiments, does not make the question of odor an important factor, except it is the odor of some distinct poison. It nevertheless displeases the esthetic, and its elimination is of course assisted by the volumetric method of ventilation. There are instances where the ventilation of a school room has been condemned solely on the basis of odor, when the corrective was not the question of the air supply, but the question of the need of bathing on the part of the pupils and of attention to their teeth and throats.

Summing up briefly, the late investigations in respect to ventilation indicate that temperature and humidity are highly important factors; that we must maintain freshness of indoor air by periodic flushing or instituting gentle air movements or combination of both; that we must avoid dust as much as possible, and that to minimize troubles from such dust as is unavoidable we must provide systems which are self-cleaning and which have heating surface if possible not too high in temperature. A study of the conditions of the evolution of the strong races shows that the air about the body has always been in motion and that the body has lived in a changeable temperature. It is of importance to add that the question is now being actively studied by a committee of the American Society of Heating and Ventilating Engineers in collaboration with the American School Hygiene Association and authoritative pronouncements are before long to be expected.

DISCUSSION.

Mr. ORRICK.—The dust problem has been one that has been of great interest to me, and within the last few years I have made more or less determinations of the dust in atmospheric air around New York. I would not quite like to follow what Dr. Soper said about the test made by him as to the condition of the air as far as metallic (steel) dust is concerned, but I have found more or less iron in the dust collected. For these tests I made use of the same apparatus which Dr. Soper used, a sugar filter to collect the dust, a gas meter to measure the amount of air and a little pump to pull the air through. We made quite a lot of determinations, and the metallic constituents were less than $\frac{1}{2}$ of 1% of the dust collected. I would be inclined to believe that some trouble would be due to silica and some of the other non-metallic constituents.

Referring to the matter of school ventilation. School ventilation has always been a very vexed subject. When I taught in a country school the ventilation was obtained by means of opening the windows about 3 in. from the bottom and putting a board in, and good ventilation, with a good

velocity of about 4 ft. a second through the space between the two sashes, would be obtained. In ordinary Winter weather, when the air outside was around freezing, better velocities would be obtained, showing that we were getting plenty of air into the school house. Later on it came to me to design a number of school houses, and the system which was in use at this time was known as the Smead System, in which ventilation was obtained by a furnace at the base of the stack. There was no blowers or pumps, and the foul air was taken out at the floor. This Smead System was very successful, and gave an average of 50 cu. ft. of air per minute for ordinary rooms containing from 48 to 60 scholars. Later on a gentleman named Tudor commenced to use fan ventilation for school houses.

In mining ventilation the amount of air required by the mining laws of several of the large States and mining division is 100 ft. per man or per animal in the mine. These figures are very much exceeded in case of fire.

Ventilation is also a matter of individuals. I remember one experience where we had an explosion in the mine. After an explosion the ventilation of the mine is spoiled. Usually the mine fan has blown out when the explosion takes place, and there is no flow of air. In this particular place the fire damp had exploded, breaking the brattices. A party immediately started down, the men bratticing in the center of the gallery and the air would come in on one side and go back on the other. I went down with the second party. The men who went down in the first gang staid about 20 minutes and were taken violently ill. I am so constituted that small proportions of bad air does not affect me, and I staid down $2\frac{1}{2}$ hours. I think that seven gangs of men came down during that time. It is a matter of individual make-up as to the effect of the carbonic acid. In this particular case I have no doubt that CO_2 was as high as 250 parts per 10 000.

I want to say one word about power house ventilation. In most of the power houses we use forced draft, and we pump enormous quantities of air out of the boiler room into the furnace and up the chimney. This makes the boiler house one of the most comfortable places in the Summer time and coldest in Winter. It is so cold in the boiler rooms in Winter time that all the windows have to be kept closed to prevent freezing of the pipes on boilers that are out of service.

In the engine room there is very little chance for natural ventilation, and what little there is is through the monitor at the top of the room. Since introducing the steam turbine, we have found it necessary to ventilate the turbine itself. In the case of the 8 000 kw. turbine, 40 000 per cu. ft. of air per minute are used.

In the case of the new large turbines about 80 000 cu. ft. would be put through a minute. The power necessary to move this air through the windings is obtained from the revolving field itself.

BROOKLYN ENGINEERS' CLUB.

No. 103.

THE DESIGN, CONSTRUCTION AND OPERATION OF HIGH TENSION ELECTRIC TRANSMISSION LINES

BY CLYDE D. GRAY, MEM. B. E. C.

PRESENTED APRIL 13, 1911.

It is the purpose of this paper to bring out some of the points that should be considered in designing, constructing and operating aerial high-tension transmission lines, voltages above 10 000 to be considered as high-tension. There has been and still is too little attention paid to the proper engineering and construction of these important links, connecting as they do, power stations with substations and consumers located many miles from the source of power.

It is due to such lines that many hydraulic developments are made available as sources of power for large communities which otherwise would suffer from the lack of power that could be purchased at a reasonable cost. This is particularly true in mountainous sections remote from sources of coal or other fuel supply or where railroad facilities are poor. This statement even applies to those more thickly settled sections where coal is cheaper, but where hydraulic power can be generated and transmitted in large quantities so as to compete in cost and reliability with power generated by steam or gas engines.

This applies not only to power generated from water but also that produced in large steam plants and distributed to substations and large power consumers in districts containing small towns and cities which would not in themselves be large enough for a power house. In the latter case one large plant suitably located using large units with a better load factor can produce and deliver power at a price to carry the additional investment in the transmission lines and substations and still make a profitable showing over the operation of several steam generating stations supplying the same district.

The sources of power at the present time that have to be considered are water power, steam, gas and oil engines. Water power is the one now most utilized for large transmission projects on account of its cheapness, and because in many cases the best power sites are remote from the market and located in districts where fuel is expensive. In many systems the hydraulic station is operated in conjunction with steam stations, the steam plant taking the daily peaks, supplying the necessary power during shortage of water and floating on the system ready to take up the load in case service

from the water power is interrupted, due to line or other trouble. Steam turbines are particularly well fitted to operate on the system in this way as they serve as synchronous condensers to increase the power factor and thus give better regulation and decrease the line losses. At the same time they are ready to pick up the load without interruption if the other source is suddenly cut off.

The distance to which power can be transmitted economically depends on the cost of fuel and labor, the railroad facilities of the district and the first cost of the complete power development, including water rights, real estate flooded by water storage, rights of way for the transmission lines, cost of power house, lines, etc. The present limit seems to be from 200 to 250 miles on the Pacific Coast. The longest one in the East is that from Niagara Falls to Syracuse, about 160 miles. The limits are being extended by the introduction of higher voltage apparatus, so that today 150 000 volts are not considered beyond the bounds of reason, 110 000 being used on 4 or 5 systems now.

The possibility of building steam plants at the coal fields where culm or other cheap grades of fuel could be used, for transmitting power to neighboring cities, has been proposed and there is one company doing this at the present time in Pennsylvania, the Harwood Power Company, which distributes power at 30 000 volts.

Water power plants are the ones principally used in connection with high-tension electric transmission owing to the low cost of generation. They are installed where water is plenty or where the cost of its storage is comparatively low. In many cases the cost of storage is high and water is scarce, so that season storage is necessary, but usually in such cases a high head can be used and in some cases the same water is used in several plants in series, the final one discharging into an irrigation system. In some cases Government irrigation projects also generate power and transmit it for pumping or power purposes. Many such power developments have been made possible and useful by the use of electric transmission for carrying the power where it could be used in existing markets or by developing new markets. The development of various electrolytic processes for manufacturing aluminum, carbide, etc., are responsible for many of the hydraulic plants and transmission systems of today. The growth of cotton milling in the South has also given an impetus to this business.

Coming now to the main part of the discussion, the transmission line, we will take up briefly some of the points that should be considered in designing and locating the line. The voltage and number of circuits are usually the first points to be decided. These depend more particularly on the amount of power to be transmitted, the allowable loss and the dis-

tance, but the character of the load in respect to power factor, load factor, desirability for securing continuous service and character of country over which the line is to be run, are also points to be considered.

In general, the voltage is determined from the allowable losses in the line with the most economical size of conductor. Kelvin's rule applies fairly well to this determination, which is, that, for a given voltage the annual cost of energy wasted or lost shall be equal to the interest on the investment. Usually each case has to be treated on its own merits. A so-called "rule of thumb" method is that the pressure in kilo volts shall be equal to the distance in miles. In any case this problem usually resolves itself into a cut and try method for the first attempts in determining the size of the conductor, which can be carefully calculated later. The total voltage drop can be taken care of by taps on the step down transformers. A starting point for conductor size is usually No. 4 copper or No. 2 aluminum for the smallest size to be used on short spans, and No. 2 copper and 1/0 aluminum for longer spans on account of mechanical strength. This being the starting point, the voltage may then be determined to keep the loss within the limits desired. By loss is meant the actual C²R or ohmic loss and not the voltage drop. This is usually kept from 5 to 10% of the delivered power. When duplicate circuits are installed, it is satisfactory to allow this loss when both are in service. If one is out for a time the generating voltage can be raised sufficiently to keep the delivered voltage at its proper value.

The number of circuits to be installed depends on the amount of power to be transmitted and the continuity of service required. In general, if it is necessary to keep the initial cost of the development low, and the system to be supplied has another plant or a steam plant kept under steam with engines or turbines floating on the system, it may be the best engineering to install but one circuit. In many cases where the voltage allows, the poles or towers may be equipped for two circuits and but one installed at first until the demand for power increases sufficiently to warrant the cost of installing the second circuit, or the loss becomes too great on one circuit.

If the system to be supplied has no other plants operating on it, it is usually considered best to install two or more circuits either on one line of poles or towers or on separate lines on the same right of way, or in cases where the transmission is a very important one and the initial expense is not considered as vital as continuity of service, it is best to install a part of the circuits on an entirely separate right of way over a different section of country in order to avoid local storms. This method gives the best assurance against interruption but involves an additional first cost of construction and increases the cost of patrolling and repairs. Two single circuits on

different routes making a loop are also good as they take the place of a double circuit.

In regard to the advisability of installing two circuits on one line of poles or towers, this is entirely feasible up to 35 000 volts on wood poles, and one can be repaired while the other is operated, care, of course, being taken to see that the dead wires are securely grounded before being touched. With steel towers, duplicate circuits of any reasonable voltage can be similarly repaired. This type of construction is cheaper than the installation of each circuit on its own poles or towers, but has the slight disadvantage that some causes of interruption will put both circuits out of service simultaneously, such as falling trees or large branches that will touch both circuits at the same time. Greater care must also be used in repair work on account of the proximity of the live circuit.

There is no advantage in single lines in respect to the usual causes of interruption, such as lightning, surges, mechanical breaks in wires, insulators, pins, poles or towers, caused by wind or ice strains on conductors and short circuits or grounds caused by conductors swinging together or into the supporting structures.

Another problem that arises is to determine the connection of the circuits, whether delta or star, and if star, whether to ground the neutral at the power house and substations or not. Engineers differ in regard to this question. For voltages up to 45 000, it is probably better to operate delta in most cases and above that value to connect star with the neutral grounded, although some systems at higher pressures are operated delta, the Central Colorado Power Company being an example.

The delta connected circuit can be operated on two wires and if single-phase transformers are used, one of a bank of three can be taken out without appreciably disturbing the voltage relations, the only effect being that it reduces the capacity of the bank. The voltage between any wire and ground is greater with the delta system for a given voltage between wires than for the star connected system. For example, on a 66 000-volt circuit the voltage between one wire and ground is only 38 000 volts when connected star, while with the delta connection it is 66 000. The star connection thus reduces the strain on the insulators. The star circuit can be operated on two wires, provided there is a dead ground at both ends of the line, but the voltage on the phases is apt to be somewhat unbalanced, depending on the conditions of the grounds, their number and distance apart. Two transformers can also be used with the same disadvantage. The grounded neutral, star connected system lends itself better to the use of the Nicholson and other similar methods of testing for broken insulators or grounds on the system.

The size of conductor is dependent not only on the losses but also on

the sleet and wind conditions, especially for steel tower construction. The allowance to be made for these factors depends on the section of country traversed by the line and the factor of safety desired. The Weather Bureau records for several years past, from stations in the vicinity of the line, should be consulted and as much local information secured as possible regarding sleet and wind conditions. The telephone and telegraph companies often have some records available.

It is generally safe to use 8 lb. wind pressure on the projected area of the wire, together with $\frac{1}{2}$ -in. radial thickness of sleet in sections where sleet forms. This wind pressure is equivalent to an actual velocity of about 56 miles per hour or an indicated velocity of 70 miles per hour calculated from the formula $P = .0025 v^2$, in which P is the pressure in lbs. per sq. ft., and V is the actual velocity in miles per hour.

The amount of sleet to be considered is a much debated one, especially with aluminum wire. Some engineers say that sleet will not form on a live conductor and not at all on aluminum, but the writer believes that it will form on aluminum, especially after the wire has been installed for some time, so that the initial greasy coating has had time to wear off and the oxide has formed on the surface. While sleet is not apt to collect on a live wire with high voltage, still there is always danger of the wire becoming dead due to some interruption and then the sleet does form.

The voltage, size of conductor, and type of connection are usually determined before the country is actually seen by the engineer, and then it is necessary for him to visit the section of country and go over the proposed route or routes for the lines as carefully as possible with the best maps available, accompanied by someone who is familiar with the territory, preferably a civil engineer who has been engaged on the preliminary engineering, so that decisions can be made regarding the route, type of construction, whether wood or concrete poles with short spans or steel towers with long spans. The route should be gone over on horseback or with a team, if it is near a highway, and notes made on a map or in a field book regarding timber, character of soil, condition of land in respect to cultivation, roughness of profile, kind of highways for transporting material, proximity to railroad stations, and any other facts that might have a bearing on the cost of construction, cost of right of way, or ease of patrolling and making repairs. Two or three of the most desirable routes should be gone over in this way and a comparison made as to the advantages and disadvantages of each. The maps of the U. S. Geological Survey are a great help in this work. If impossible to visit the locality, they may even give a fairly good idea of the various routes if made up from recent surveys, but the older ones are sometimes misleading, especially in the location of highways, as oftentimes these have been changed.

From the results of the above reconnaissance, may be decided whether the country would be best for poles or towers, if there is any question in this respect, the approximate cost of right of way, clearing, hauling material, digging holes, etc.; also whether the locality is subject to wind, sleet or lightning storms of especial severity, all of which factors must be considered before deciding upon a definite route.

All of this preliminary reconnaissance work should be carried on as quietly as possible without exciting the attention of the land owners, whose prices for property invariably increase rapidly when the project is known. In many States power companies do not have the right of eminent domain, so that it becomes necessary to purchase the right of way or easements. Consequently, a good right of way man, who has had considerable experience in securing rights of way for railroad or transmission lines, should be secured and given considerable latitude in his dealings with the land owners. This man if possible should be acquainted locally, so that he may know how best to approach the people.

The problem of securing reasonable prices for rights of way is much more difficult for a high-tension line than for a railroad, as there are no attendant advantages to the land owners unless they are broad-minded enough to realize that the general community will be benefited by cheap power which will benefit them indirectly. Such persons are, however, usually scarce. It is well, if possible, to give the right of way man two alternate routes to work on in case he encounters any especial difficulty in one route.

The right of way may be purchased in fee simple, in which case it may be fenced or not, depending upon circumstances. Usually the farmers are allowed to cultivate the land, provided they do not injure or interfere with the line in any way. This is advisable, as it keeps down grass and brush which might cause trouble from fires or require cutting periodically. The right to enter the right of way strip either by patrolmen or repair wagons should be reserved. It is best to have nothing stated in the deeds regarding cultivation but to allow it, so that in case the power company desires, it may fence off its property.

Often easements are obtained for setting poles or towers. These may be perpetual or limited by time, preferably the former. In this case the right to enter the property, patrol the line and repair it must be secured. If possible the center line should be defined across each property without the number and location of poles or other structures specified, as it often happens that additional ones may be desired later, which gives the owner an opportunity for canceling the original contract and demanding exorbitant prices under the new agreement.

It is hoped that all the States will give power companies the right of

eminent domain, as transmission lines tend to husband natural resources and increase the prosperity of the districts which they serve, and it is hoped, that by means of intelligent and temperate discussions of conservation, these rights will be secured to power companies in all localities.

The width of right of way to be secured depends on the number of pole lines and the cost of land, but should not be less than 100 ft. for any important line, and should be entirely cleared of trees and brush, and if the section is subject to forest fires, fire trenches should be plowed along its edges to help protect the structures from damage and prevent fires from crossing the right of way if possible. All trees outside this right of way strip that would reach the line in falling should also be cut. All timber and brush should be disposed of in some way or burned, so that dead branches will not be picked up by the wind and blown across the circuits or furnish fuel for forest fires.

If easements are secured the clearing should be done in the same manner.

In rough country it may be necessary to make wagon roads or paths, so that the construction, patrolling and repairs may be done more easily.

After the right of way options have been secured for the entire line, with more or less flexibility as to route, a survey party should be put into the field and the center line of the right of way located, care being taken to make the line as straight as consistent, and where a change of direction has to be made, to make it on a curve, so that the turn will come on several structures instead of one, so that standard structures can be used. Topography should be taken for a strip about 1 000 ft. wide and all buildings, fences, highways, telephone, telegraph and other pole lines definitely located and notes regarding cultivation and trees made. The plan of this strip should be plotted on a scale of 1 in. equals 400 ft., together with a profile of the center line on a scale of 1 in. equals 20 ft. vertical scale. If it is to be a steel tower line with long spans, another profile should be made with a horizontal scale of 1 in. equals 80 ft., and a vertical scale of 1 in. equals 20 ft. This profile should show the height of other lines crossed and the location of highways and property lines.

The type of construction to be adopted depends on the importance of the system, number of circuits needed, first cost of construction and the cost of maintenance and repairs. The cheapest in regard to first cost for a single circuit is, of course, a wood pole line, the poles being spaced as far apart as possible consistent with safety. This depends on the size of conductor and the wind and sleet conditions to be encountered. In the writer's opinion, 200 ft. is the maximum span allowable and from 125 ft. to 150 ft. is better for average conditions with moderate-sized conductors. This refers to a single three-phase circuit with grounded wire for lightning protection.

The strains in the wire and poles should allow for a factor of safety of at least two under maximum wind, temperature and sleet conditions, the strain in the wires and their supports being found by the use of the formula

$$S = \frac{WL^2}{8d}$$

in which S equals strain in lbs., W equals the equivalent weight

of 1 ft. of conductor in lbs., L equals the length of span in feet, and d equals the deflection or sag of conductor in feet (W is the resultant weight of conductor, including ice and the wind pressure exerted on the conductor, including ice, taken at right angles). This gives the strain on the conductor and on the insulator support for pin type insulators. If suspension type insulators are used, the strain on the insulator support is less than on the wire by about 15%, due to the fact that if the wire breaks, the insulator moves from its vertical position and takes the direction of the wire, thus increasing the deflection and decreasing the strain. The effects of temperature and elasticity can be neglected on short spans.

The kinds of timber principally used in wood pole construction are chestnut, cedar, cypress or juniper, redwood and pine, the latter being used principally when impregnated or treated with some wood preservative. All of these woods will rot more or less at the ground line and may be protected to prevent this action. As the price of poles goes up due to the scarcity of timber, it becomes more necessary to prolong their life or make use of concrete or steel construction.

The methods of treating are, impregnating the entire pole by the vacuum process, using creosote, zinc chloride or other wood preservative, the open tank method of boiling the butt in one of the same preservatives for 7 or 8 ft., and the brush treatment of the entire butt or only the section around the ground line extending 2 ft. below and 1 ft. above the ground. In the writer's opinion the treatment of the entire pole is not justified and possibly the second method may also be too expensive at the present time, so that it is a question of using the brush treatment, which may increase the life from 25 to 50%, if any treatment is justified.

Among the advantages claimed for wood construction are: cheapness in first cost, ease of construction, as no special workmen or apparatus are needed, the advantage of having the insulation of the pole between the conductor and the ground, which is of doubtful value on high potentials, and the possibility of having a cross arm or pole top burn off from an arc caused by a defective insulator without interrupting the service. A single line of poles of this kind may in some instances be installed at the side of highways, electric or steam railways where permitted, thus saving the cost of right of way and rendering patrolling easy.

Some engineers and operating men prefer 2 wood pole lines, each carry-

ing a single circuit, to a double circuit wood line, even though their first cost and maintenance are much greater, believing that 2 circuits on separate structures even on the same right of way are not so liable to interruption from a common cause, and also that repairs can be made on one safely while the other is alive. Some prefer 2 wooden pole lines to a double circuit steel tower line for the same reasons, even with the greater cost of the pole lines and the much greater cost of maintenance. It has always seemed to the writer, however, that the steel construction is the better on account of the fewer insulators per mile and the lower cost of construction and maintenance. The life of the best wood construction is not over 12 to 15 years, while steel towers should be good for an almost indefinite period, provided they are properly maintained.

No data is available regarding the life of steel towers, as they have not been used long enough to determine their life, especially if galvanized. Galvanizing should be good for 10 or 12 years and then by painting every 2 or 3 years with some good preservative paint, such towers ought to last 40 or 50 years, or even longer.

The writer has a section of $3\frac{1}{2}$ -in. x $3\frac{1}{2}$ -in. x $\frac{1}{4}$ -in. plain angle iron that was once one leg of a windmill tower that had been installed 19 years which is not corroded to any extent, except at the ground line where it was practically eaten away. If this had been properly protected for a distance of 18 ins. at this point, the tower would still be standing, for the rest of the angle was practically as good as when installed.

Single circuit pole construction does not lend itself well for supporting a grounded arrester wire over the power conductors, as some sort of an iron support must be used. On a double circuit wood pole line this wire can be carried on the top of the pole, preferably installed on a pole top pin and insulator, the insulator merely being used to furnish a smooth support for the wire and to which it can be tied. Fig. 1 shows a typical single-circuit wood pole line for 66 000 volts.

Among the other disadvantages of wooden construction are the increasing cost of poles in all sections of the country, the decreasing factor of safety of the line with age of the poles, and the difficulty of transporting poles in mountainous regions.

For wood construction the cross arms should be of extra size. Iron pins with separable thimbles for cementing into the insulators should be used, and in general the construction should be the best in all respects.

Concrete poles are coming into use, replacing wood, but they have been of such recent construction that no conclusion can be made regarding their durability. They will doubtless be used more and more as wood increases in price and more data is available regarding their characteristics. The

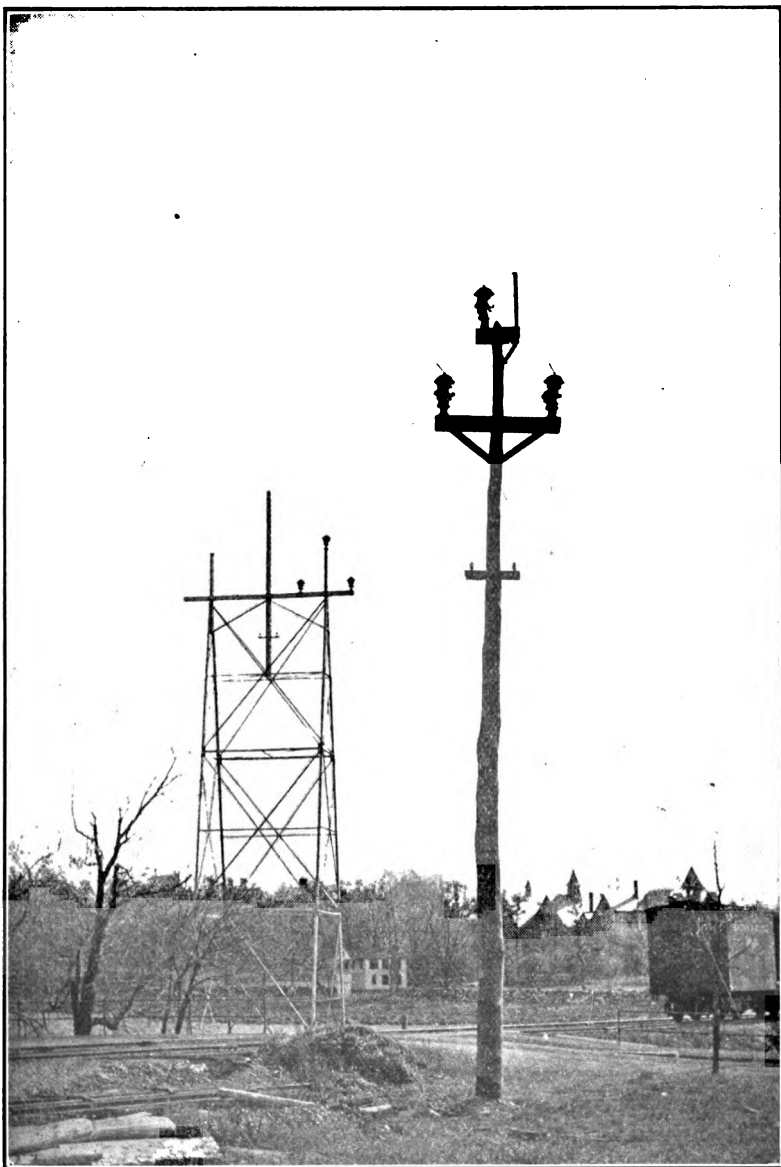


FIG. 1.—TYPICAL 66,000 VOLT CONSTRUCTION. DOUBLE CIRCUIT TOWER AND SINGLE CIRCUIT WOOD POLE.

practical disadvantages of concrete poles are their high first cost in manufacturing, hauling and erection, and the difficulty of obtaining uniform product, as in any concrete work where so much depends on the personal equation of the workmen. In many sections of the country it would be difficult to obtain the necessary materials, such as sand, stone or water within reasonable distance of the line and the high cost of transporting the poles from the point where made. There is also the problem of fastening the cross arms to the poles so that the fastening will be substantial and not corrode.

Wood and concrete poles lend themselves best to the use of pin type insu-

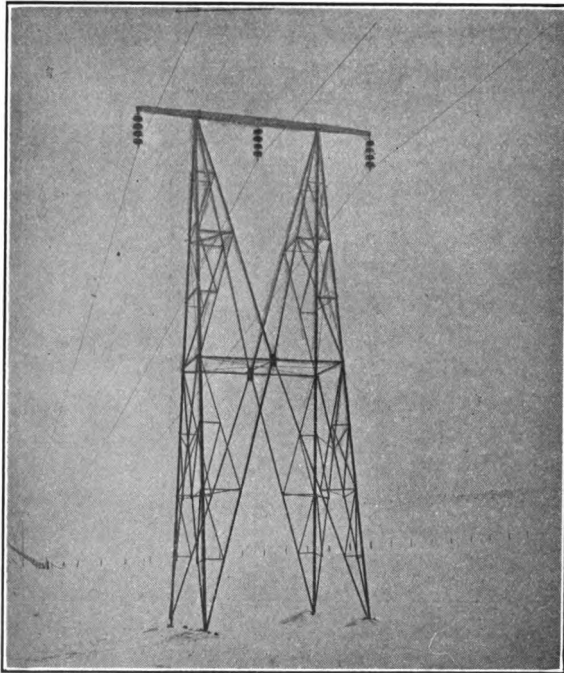


FIG. 2.—110,000 VOLT, SINGLE CIRCUIT, STEEL TOWER.

lators which may be used with reasonable safety up to 66 000 volts, beyond which voltage, suspension type insulators must be used. The latter require greater lengths of supporting cross arms on account of the tendency of the insulators swinging as pendulums about their supports, which increases the strain on the cross arm and the torsional effect on the pole.

The use of steel towers is next in order, as we will not consider tubular or small built up latticed steel poles, the cost of which is too high to consider for high-tension line work. In some cases where the lines are run

along railroad rights of way, such as the New York Central, New Haven or Long Island R. R. in this vicinity, where the voltage is restricted to from 11 000 to 22 000 volts, they may be used but their cost is very high.

Steel tower, long-span line construction is the best in nearly all cases where private right of way or easements can be secured, and it is possible to use high voltage, so that the conductor is kept within a reasonable size. These towers should be made up of small structural shapes as angles and channels. Some engineers and manufacturers of towers make use of rods, flats and pipes, but it is best to use only angles and channels bolted together in the field. Certain members, however, such as cross arms for holding the insulator supports and the grounded wire support, may be made of 2 channels latticed together and riveted in the shop, so that the whole member can be galvanized. The other members should be galvanized after the holes are punched, galvanized or sherardized bolts being used in all cases.

In designing towers of this kind it should be borne in mind that they cannot be designed by ordinary structural or bridge formulas, as the factor of safety and deflection of the different members are so different, a factor of 2 or 3 being used and deflections that would not be safe in other types of construction, so that the design is more or less the result of experience and tests on sample towers built up and actually tested with the different loads and combinations of loads that may be imposed in actual service. In making such tests, if the material for the test tower has not been galvanized, an allowance should be made as the strength may be decreased from 15 to 20% by galvanizing, because the shapes are so thin, $\frac{1}{8}$ -in., $\frac{3}{16}$ -in., and $\frac{1}{4}$ -in. material being commonly used.

Towers should be designed for the standard height and strength desired and then extensions of 10, 20 or 30 ft. designed to fasten to the bottom of the standard towers to make higher ones. These extensions should be arranged to bolt to the corner legs of the towers without any drilling or fitting in the field. All towers should be designed to take the same wire strain as the standard towers, in fact, the strain in the wires and the clearance to ground should be kept constant and the sag and span varied. In this type of construction it is interesting to note that the cost of line per mile is practically the same for different heights of towers and lengths of span with the same size conductor and strain on it. This statement, of course, applies within certain limits and could not be used in all cases, but it works out with strains in wire and supports of about 2 000 lbs., with a 25-ft. clearance to the ground at the center of the span, that 50-ft. towers spaced as far apart as possible to give a factor of safety of about 2 in the minimum size of conductor used give about the most economical and reasonable height and strength of towers. These will give spans of from 575 ft. for No. 1 copper,

to 500 ft. for No. 4/0 copper. When the strain exceeds 2 000 lbs. in the wire it is necessary to increase the thickness of the material in the towers, which increases their cost and although allowing higher towers and longer spans, does not decrease the cost per mile.

Double circuit towers of the ordinary construction support, six power conductors, one grounded wire and two telephone wires, such as shown in Fig. 3. The towers should withstand torsional strains due to one circuit being broken one side of the tower, or both circuits being broken on the same side, that is each tower should be a dead-end tower. Under these tests the

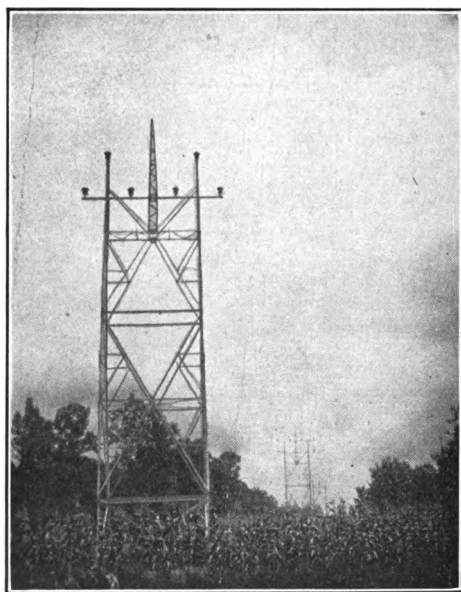


FIG. 3.—DOUBLE CIRCUIT TOWER, 66,000 VOLTS.

steel should not be stressed beyond its elastic limit and no permanent deflection of any member take place. In some cases it has been thought best to install dead-end towers at intervals of say $\frac{1}{2}$ mile, the intermediate towers being of lighter construction, so that they would probably fail if the wires were broken. It has always seemed to the writer that the slight additional cost of having each tower a dead-end or anchor tower is justified on account of the greater factor of safety in the line.

When shipped the towers should be packed in bundles of about 200 lbs., unless some special difficulty prevails. All pieces should be plainly marked and the bundles arranged so that a complete tower can be delivered at the

site of erection without breaking bundles. Bolts, washers and other small parts should be shipped in boxes or kegs packed individually for each tower. It is usual to have the tower manufacturer supply the pins for pin type insulators and fastenings for the ground wire. The power wire pins should have separable thimbles that can be cemented into the insulators at the insulator factory. The telephone insulators can best be cemented direct to the pins. The grounded wire support is usually a mechanical clamp or smooth casting shaped like a cable top insulator, to which the wire can be tied.

The spacing and location of wires differs for different voltages, but a safe rule to follow is that on long spans nothing less than 60 ins. be used up to 60 000 volts and this increased 1 in. for each 1 000 volts over 60 000. With suspension type insulators care should also be taken to see that when the insulators swing with the wind they do not come too near the supporting structure. It is usual to assume them swinging to an angle of 45° from the vertical and in this position the wire should not be nearer the supports than 20 ins. for 60 000 volts, plus $\frac{1}{2}$ in. for each 1 000 volts over 60 000. It often happens that light wires, especially aluminum, will swing beyond 45° , in fact, the writer has seen wires blown out nearly horizontal, in which case the clearance mentioned above should be maintained with the horizontal position of the wire.

The telephone circuit, if one is to be installed on the towers, should be located below the power wires and as far from them as consistent with the ground clearance. Power wires should be at least 22 or 23 ft. above the ground at the lowest part of the span, and the telephone wires might be 6 ft. lower. This minimum clearance depends on local conditions.

The anchors for the towers are always separate from the corner members and arranged to bolt to them, so that they can be set before the towers are erected. The best form of anchor consists of an angle about 6 ft. long, with a cross consisting of 2 pieces of the same material about 2 ft. long, bolted to it. This type will usually develop enough holding down power to satisfy the requirements in all kinds of ordinary soil. In soft ground special footings may be needed, depending on the local conditions, and if stones are available, it is well to place some large flat ones on the bottom pieces before tamping the earth in any kind of soil. When solid rock is encountered, the tower legs can be held down by foundation bolts grouted into holes about 3 ft. deep drilled into the rock.

The anchors need protection only at the ground line, and a good plan is to install a sleeve of grout about 9 ins. in diameter around them, extending 6 ins. above and 24 ins. below the ground line, the top being carefully roofed to shed water. Some lines have special concrete anchors, to which the towers are fastened by holding down bolts, others have the entire anchor

encased in concrete and some have no protection whatever, but the writer considers that the sleeve of grout will satisfy all requirements.

In any kind of construction there may be cases in which special designs are necessary, such as crossings over telephone, telegraph and other circuits, railroads, streams or long spans. The subject of crossings over railroad, telephone and telegraph lines is now being discussed by joint committees representing the National Electric Light Association, the American Railway Engineering and Maintenance of Way Association and the American Electric Railway Association, and standard specifications are being worked out which it is hoped may be adopted.

Stream crossings or especially long spans are usually best worked out for each individual case. The chief difficulty in their design up to quite recent date has been of obtaining insulators of sufficient strength and insulating qualities to hold the conductors. Various methods have been used, one in which several pin type insulators are mounted in series to the top of which the cables can be fastened. With the introduction of suspension type insulators the problem was simplified somewhat, as several sets of these insulators could be used in multiple, but the insulator manufacturers are now prepared to make special units that will have sufficient strength and insulation in one piece up to 60 000 volts.

For long spans, special cable is usually needed of high tensile strength, such as crucible or plow steel or one of composite material, consisting of a steel core with copper coating, which is good where the utmost tensile strength is not required and some conductivity is needed. In this long span work, the elasticity or spring action of the cable, as well as its temperature coefficient become quite important factors, especially if a certain clearance must be maintained, the first being the most important. In such cases it is best to make a series of tests on the material to be used to determine its elongation under various amounts of stress. With this data the actual length of cable in the span can be closely calculated, and the cable correctly measured and cut to length. It is also best to install turnbuckles in the cables to adjust them, so that they will hang parallel and allow for proper adjustment in length if not measured and cut correctly.

For 1, 2 and 3 circuits, it is best to arrange the wires in a horizontal row and to omit the grounded wire. It has seemed advisable in some cases to install an extra conductor that can be connected in place of one of the others in case of trouble, but this seems hardly necessary if the proper factors of safety are used in the design of the structures and cables. A typical stream crossing for a 2 000-ft. span is shown in Fig. 4, carrying 6 $\frac{3}{4}$ -in. plow steel power cables and 2 $\frac{5}{8}$ -in. plow steel cables for telephone service.

Coming now to the construction of the line, there are no especial features in wood pole line construction that are novel, and the location of the line on private right of way, some of which might possibly be rough, precludes the use of derricks or other apparatus for raising the poles so that the method of raising them by hand with pike poles is ordinarily used. The cross arms, ground wire supports and insulator pins are usually put on before the poles are raised and the insulators installed later, just previous to the stringing of the wire, to prevent breakage and loss by theft or otherwise.

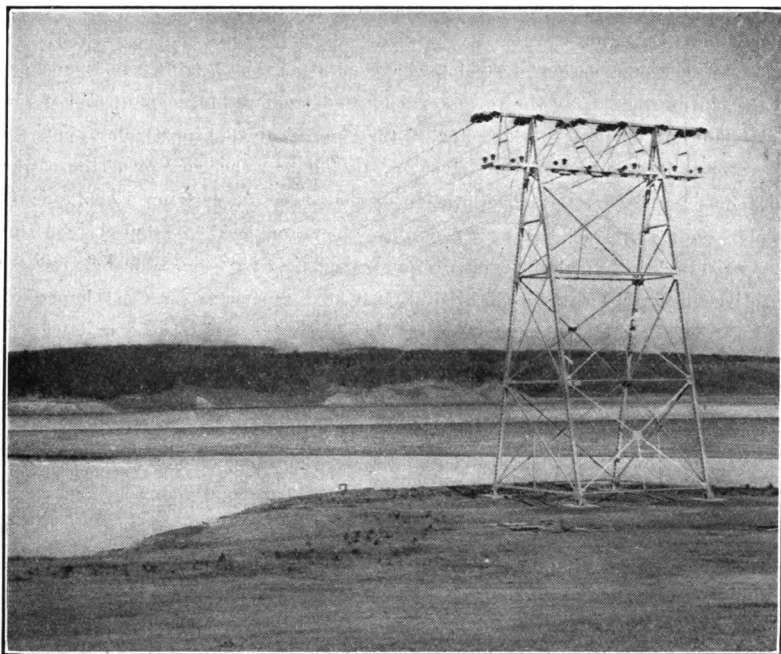


FIG. 4.—2,000 FT. SPAN TOWER; 66,000 VOLTS, DOUBLE CIRCUIT.

Oftentimes for voltages of 35 000 or less, the insulators are installed when the poles are on the ground.

The wires are usually strung by hand or with a team. If the ground is rough or aluminum wire is used, which is easily abraded by dragging on the ground, it is run through snatch blocks attached to the poles or towers, so that it does not touch the ground. Sometimes rollers are used which may be fastened to some parts of the cross arms or towers over which the wire can be hauled. Smaller wires can be hauled over wooden cross arms without injury to either, but the larger sizes are apt to injure the cross arms. It

is not wise to haul wires of any size over steel structures. After the wire has been hauled out in convenient lengths, depending on its size, it can be spliced, sagged and tied to the insulators.

Care must be taken in the interval between stringing the wire and the turning on of current to prevent theft of wire. In fact, it is often advisable if current is available at one end of the line to start work on this end, and at times when the workmen are not employed, to make the wire alive, so that anyone trying to steal the conductors will find them "hot."

For concrete pole construction, the same conditions prevail, except that it is impossible to pike the pole into place and some sort of derrick or gin pole must be used.

In the construction of steel tower lines after the clearing has been done, the station points for the towers are located from the office plot, and if satisfactory in respect to character of the ground at that particular spot, the center is located and stakes driven locating it and the corners of the tower. If it is found that the office location of the tower places it on a spot unsuitable on account of the presence of boulders or local roughness requiring considerable grading to drain all four corners, it may be relocated and the adjacent tower locations changed slightly to compensate for this change.

It is advisable to locate towers near highways and also near telegraph and other pole line crossings, so that there is a maximum clearance at these points. It is also desirable to locate them near property lines, so that in case there is any trouble with one of the property owners, the tower can be taken from his property and installed on the adjacent one.

In the construction of the line, the holes are usually dug by one gang, and the anchors set and tamped in by another. The anchors must be set correctly by means of a steel template, so that they will be properly spaced and have the proper inclination to take the tower legs. They must also be absolutely level, so that the tower will be perpendicular when erected. If the sleeve type of protection at the ground line is used, a sleeve of thin sheet iron is installed when the hole is filled and tamped, within about 24 ins. of the ground line. The sleeve is then filled with grout and the rest of the hole filled with earth and tamped. The ground usually settles around each leg, so that it is necessary to fill the hole again after several weeks when the ground has thoroughly settled.

The towers are assembled complete on the ground by one gang and erected by another gang, the erection usually being done by the use of a gin pole or derrick. In some cases two of the tower legs are fastened to their anchors by means of temporary bolts to hold the tower in position while being raised. In other cases a stiffening frame is fastened to all 4 legs and this frame fastened to the ground on 1 side during the raising process.

The erecting has to be done very carefully, so as not to drop or strain the tower, which is easily injured.

The main insulators are usually installed just before the wire is strung. After the wires are strung as described before, they are ready to be sagged and tied. One of the bottom wires is ordinarily sagged by the use of paint spots on each tower, these being at the elevation of the lowest part of the wire catenary, being located from the profile of the line which has the towers and catenary lines drawn on it. A man climbs one tower until his eyes are on a level with the spot on this tower, sights at the spot on the adjacent tower and has the wire raised or lowered until its lowest point is at this level. The wire is then clamped fast and tied to the insulator.

All the wires are usually installed at the same time and the telephone wires connected up for use with portable telephone sets, so that the construction gangs can keep in touch with each other and the construction office.

The methods of fastening the wires to pin type insulators consist of different ties or mechanical clamps. For ties the double, or so-called Mershon tie is good, especially for aluminum wire, where it is necessary to protect the wire for some distance beyond the insulator head against arcs from the upper petticoat. This tie consists of two ties, 1 on each side of the insulator. One end of the tie wire is started at the head of the insulator and served around the main conductor outward for 3 or 4 ins.; the wire is then carried around the tie wire groove of the insulator and the end again served outward from the other serving, until the main conductor is covered for 3 or 4 ins. beyond the edge of the upper petticoat of the insulator. Another similar tie is used on the other side of the insulator. It is usual to protect the conductor in the wire groove of the insulator with a sleeve of the same material as the conductor. This sleeve extends just beyond the head of the insulator. It is usually of U section, with the ends swaged out so that it will not cut the conductor, and when it is installed it is hammered down on the top so that it will be held in place.

Mechanical clamps are also used, but in the writer's opinion, are not as good as the above tie, as they tend to cut and abrade the conductor and do not protect it from arcs. The above protecting sleeve and method of tie is especially desirable when aluminum wire is used, which is more easily abraded and effected by arcs than copper.

For use with suspension insulators various types of mechanical clamps are used, designed so as not to injure the wire.

The problem of obtaining satisfactory methods of splicing the conductors on long span work is a difficult one, as the strength of the conductor is limited by the strength of the joint. The cable itself may have only 75% to

90% of the tensile strength of the individual strands and the joint only 85% or 90% of the strength of the cable, so that the combined efficiency of the joint referred back to the tensile tests on individual strands may be from 65% to 85%. In some rare cases, however, an efficiency of from 90% to 92% has been obtained. The joints that seem best adapted to this work are the twist sleeve joints made longer than usual so that three or more complete twists of the conductor can be made. Care should be taken to see that no joints occur in especially long spans where the cable is stressed more than usual.

After the wire has been strung and tied it is necessary to make a very careful inspection of the line to detect poor ties, broken insulators, etc. A careful, reliable man should climb every tower and inspect each insulator and tie carefully. Ringing the insulator with a piece of metal will usually detect cracked petticoats.

Great care must also be used when the current is first turned on the circuit to see that no workmen are on the line and low voltage should be impressed at first and gradually raised to 15% or 25% above normal or whatever excess pressure can be obtained without injuring the apparatus supplying it. This should be done on open circuit at the receiving end and the circuit breakers should be set as low as possible during this time so that they will trip out easily in case of trouble. This excess pressure should be kept on for several hours and after this, normal pressure for several days if possible before any power is taken over the line for commercial purposes. During this preliminary period the patrolmen should be started on their duties and the station operators should stand their regular watches. If the substations are completed, the current can be switched into them and the transformers operated on no load, provided they have been dried out and are ready for voltage. In some cases the line has to be run on very low voltage for drying out the transformers in the substations on short circuit heat runs if no current is available there from other sources.

The proper operation of the line is very important, as its reliability in regard to interruptions and service depends on the ease and quickness with which repairs can be made when accidents happen. No line can be constructed that will not have shut downs occasionally and the best line is therefore the one that has the least number and for the shortest time.

The causes for shut down are many—defective insulators being the principal one. These may be either broken mechanically or punctured electrically by surges or lightning strokes. Large pin type insulators seem to have a great attraction as targets for shot and stones. People also like to throw pieces of wire over the circuits to see the fireworks caused by an arc. These things are hard to prevent, but if a few offenders are caught in the act,

arrested and taken to court, it usually lessens the trouble. In many cases if the public is properly instructed through the newspapers or otherwise, that the operation of factories, electric lighting systems, etc., depend on the transmission lines and are told that they are causing other people hardship when they do such things, it often happens that they will see the reasonableness of the request and will not cause any more trouble.

Other causes of interruption are the arcing over of insulators or wall bushings under snow or rain conditions, together with an excessive rise of potential at the same time. This can be lessened by using insulators having a large factor of safety, three being usually sufficient. Several different schemes have been proposed to discharge the line temporarily before the power arc has an opportunity for puncturing or destroying the insulator when excessive potential arises and causes spillovers. Experiments are being made with "phase protectors" to ground one phase when this action takes place without interrupting the service. One large power company is equipping all its insulators with so-called arcing rings, which consist of a grounded ring surrounding the lower petticoats of its pin type insulators at some distance from the petticoat, to which any power arc will jump from the head of the insulator, thus saving the insulator from the effects of the power arc playing over its surface.

Large birds often short circuit or ground the line by flying into it or by resting on one of the lower wires and getting their heads into the upper wire.

Salt fogs together with dirty insulators formerly caused trouble, but with the modern design of insulators using greater factors of safety, this cause is practically eliminated.

Lines located near cement works or other factories causing fine dust need very careful attention and frequent cleaning of the insulators.

The charring or oxidizing action on wood pins is also a frequent cause of trouble, and in the writer's opinion only iron pins should be used on high-tension lines.

Occasionally wires break due to defects in material, but such accidents are rare, as the factor of safety should take care of most cases of this kind. Careful inspection during construction also tends to prevent this trouble. The failure of the supporting structures is also a rare occurrence if they have been properly designed and if their footings have been properly set.

Careful patrolling has much to do in lessening mechanical troubles on the line. Important lines should be gone over every day and others not so important twice a week, although some sections of the line particularly subject to trouble should be patrolled oftener.

Supplies for repair work should be located at about 2-mile intervals along the line so that they can be reached easily and carried to the break in

a short time. Each patrolman should carry a portable telephone set, some few tools, including a come-along, 1 or 2 wire splices, 2 or 3 tie wires and a grounding chain for grounding the line when he is working on it.

Small houses or booths should be placed at intervals with stationary telephones installed in them. They should also contain repair supplies and in cold climates, a small oil stove and some canned goods, coffee, tea, etc., for the convenience of the patrolmen. At junction points or other special switching towers, it is advisable also to provide sleeping quarters for one of the patrolmen so that he will be available at night to operate the switches, which are usually of the knife-blade type. Telephones should also be installed in all patrolmen's homes so that they can be reached at any time.

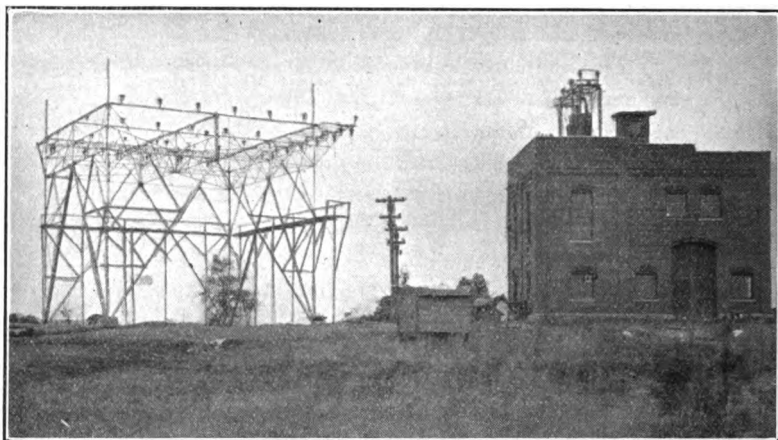


FIG. 5.—TYPICAL SECTIONALIZING AND BRANCH-OFF STRUCTURE; 66,000 VOLTS.

The circuits should be sectionalized at least every 10 miles by disconnecting switches, and at all branches, the main circuit should be sectionalized and switches installed in the branch line. Such a structure is shown in Fig. 5. The main circuits are sectionalized and a branch taken into the substation. Made-up jumpers should also be kept at these points so that the good wires of a section can be used by connecting them to the similar wires of the other circuit, provided it will take several hours to repair any break.

An important junction points oil switches instead of disconnecting switches should be installed on the branches so that the circuits may be switched under load. These should preferably be made automatic so that any trouble on the branch will not interrupt the main line. Such switches may now be obtained suitable for installation out of doors so that no houses are necessary.

Another problem is that of cutting out one of two circuits operating in parallel at both ends, leaving the other in service. This can be done by means of reverse current or differential relays if there is a source of power at both ends to keep the voltage up, but when the receiving end has no generating capacity the problem is more difficult. This is being worked out, however, and it is hoped that a solution may be found in the near future. A successful apparatus of this kind would greatly lessen interruptions to service on the majority of transmission lines or other systems where two or more circuits or feeders are being operated in parallel.

One of the greatest adjuncts to successful operation is a reliable telephone system. This should be located on the right of way of the line so that the patrolman can reach it easily and should be installed on a separate line of poles if possible, located as far from the high tension lines as the width of the right of way allows. Often times, however, it is impracticable on account of the cost of construction or pole rights, or width of right of way to have a separate line of this kind and so the telephone circuit is installed on the same structures with the high tension circuits. This naturally brings the telephone lines near the high tension wires so that the static and magnetic effects from the power wires are of considerable amount, requiring special apparatus for the protection of the instruments and persons using the telephones. This problem is being solved gradually, however, and it is thought that reliable lines will be secured eventually.

It is often advisable to have the telephone system also fitted for operation with telegraph instruments so that, in case the telephone instruments are out of order or one wire is grounded, signals can still be sent over the good wire and the ground. Long distance telephones of the Bell or other systems should be installed in the power houses, substations and other important points for use in emergencies.

All instructions for operating the system should come from a head dispatcher, who should be available at all times for issuing orders for the regular routine and in cases of trouble. This obviates all chances of confusion in switching and in getting the line back into service after an interruption.

The costs of construction vary so widely, due to local conditions, transportation, cost of materials and labor, section of the country in which the work is to be done, etc., that the writer hesitates giving anything but a few comparative costs, based on average conditions. However, a few costs of this kind may be interesting and in the table below is given the costs per mile of several different types of construction for a three-phase 60 000-volt, 60-cycle circuit with No. 1 copper wire and suspension insulators, using 4 10-in. discs together with a suitable grounded conductor carried above the

circuit. These figures do not include the cost of right of way, surveys, engineering or contractors' fees:

One single circuit wood pole line.....	\$2 550	per mile of route.				
Two " " " " "	5 100	" " " "				
One " " steel tower "	2 950	" " " "				
Two " " " " "	5 900	" " " "				
One double " " " " "	4 600	" " " "				
" " " " " " (with one circuit installed).....	3 700	" " " "				

The above estimated costs are based on the use of 40 ft. 8 ins. top chestnut poles spaced 175 ft. apart, the grounded wire consisting of No. 8 copper-clad wire, with the main wires supported on steel cross arms and the grounded wire on the top of the pole. The single circuit steel towers have bases about 14 ft. square and the lower wires 50 ft. from the ground spaced 500 ft. apart with No. 4 copper-clad grounded wire. The double circuit steel towers have the same characteristics as the single circuit.

From the above figures, may be noted the slight increase in cost of a single circuit steel tower line over a wood pole line. Also the saving in cost of a double circuit steel tower line over 2 single circuit wood pole lines or steel tower lines, so that, in the writer's opinion, the double circuit steel tower line is the one to install in most cases where two circuits are needed, unless the system is a very important one and the initial expense of two lines on separate routes justified in order to secure continuous service.

DISCUSSION.

Mr. DONNELLY.—I wish to express my appreciation of the very great care that is shown in the preparation of this paper and the valuable detailed information which it gives us relative to high-tension lines on the Pacific Coast. I am perhaps more particularly impressed from the fact that I have just returned from a visit to Los Angeles, San Francisco and Seattle, and have had an opportunity of seeing some of the lines referred to. I was told that in the neighborhood of San Francisco it is necessary to have men to remove the dust from the insulators and I should like to hear if Mr. Gray has any information on this subject.

Mr. GRAY.—That is perfectly true. We have had that trouble out there. The dust in that country will accumulate, especially in the long dry seasons. There is another cause for this condition, and that is, from the locomotive oil. When the locomotive stops and starts it throws a lot of oil globules out of the exhaust and they will collect on top of the insulators, where a lot of dust has already accumulated, and a solid substance is formed. I think I have already mentioned about wires located near cement works. On the Niagara, Lockport & Ontario line the insulators have to be wiped off every week during the dry season in such places.

Mr. WREAKS.—Do you have any trouble with copper wiring being eaten away—giving out—

Mr. GRAY.—Not at all.

Mr. WREAKS.—I heard of a case not very long ago where some people had trouble with some stranded copper wire with hemp core. Have you had any trouble with that kind of wire?

Mr. GRAY.—We have never had any trouble of that kind. We have never believed in the hemp core and never used it; use copper core in preference. Sometimes when we do not need special strength, we use 6 strands of hard drawn and a softer core. I believe some people claim to have had trouble who use the hemp core, which has been soaked in oil. I do not know anything about it personally.

Mr. WREAKS.—Does not the salt air cause the bare copper wire to corrode?

Mr. GRAY.—It does to some extent; that applies also to aluminum. A great many make complaints about aluminum wire, stating that it corrodes after being exposed to salt air: That is perfectly true. However, I know of some aluminum circuits installed in the coke regions in Pennsylvania, where there is all kinds of sulphur in the air, and this wire seems to keep in good shape.

Mr. ———. —You allow about 25% shorter span near special towers?

Mr. GRAY.—Something in that neighborhood; just enough to allow for lower wire stresses on the special structure.

Mr. DONNELLY.—While in the West I was impressed with the difference between the unit cost of electricity on the Pacific Coast and the prices ruling here. Can Mr. Gray give us the relative cost?

Mr. GRAY.—That depends altogether upon the cost of the entire development, including water rights, cost of hydraulic development and transmission lines. There is one reason why water power is used in the West. Fuel is very expensive, and when you get away from the oil fields the cost is still more higher.

Mr. DONNELLY.—Boats are operated between Seattle and Tacoma with oil as fuel at 80c. a bbl., and oil is used in Seattle for generating electricity to take care of peak loads. I was also told of an instance where current for pumping water used in re-grading was supplied at 4/10c. per kw. hour. This was for 24-hour current, and is considerably below anything I have heard of in the East. On account of the high price of labor in the West and the unusual facilities for obtaining water power, I believe there will be very large developments of electric power in that part of the country.

Mr. GRAY.—Yes, oil decreases the cost of production where large storage is not necessary, or where it can be secured without paying excessive freight rates.

BROOKLYN ENGINEERS' CLUB.

No. 104.

PHYSICAL APPRAISAL

BY WILLIAM C. BOYRER, MEM. B. E. C.

PRESENTED MAY 11, 1911.

The subject of physical appraisal is one that has become of general interest in connection with the subject of municipal control of public utilities. The obtaining of a valuation of the physical property of a public utilities corporation necessitates, however, the consideration of many features, some of which are of a rather vague nature.

Supposing for argument's sake that the market value of the physical property belonging to a public service corporation could be determined definitely for the period during which the appraisal is made, it is perfectly evident that this market value would depend largely upon the use to which the property is put. For example, the market value of a car barn used as a car barn would be very different from that of the same barn considered as residential property. Therefore, no definite value can be placed upon a piece of property, unless it is distinctly understood that the nature of its service remains fixed. This is the assumption upon which the following discussion is based.

Physical appraisal may be determined in several ways. The market value of the property at the time of appraisal may be sought. This value is very indefinite, as it may mean anything from that placed upon it by a buyer who intended to continue its original use to that placed upon it by the "junk man." Again, the original cost to produce the property may be sought. This is difficult to obtain with any degree of accuracy since if the property had been in service for any length of time, many pieces of apparatus originally installed will have been replaced; and should it so happen that the books of the corporation in question have not been kept in such a manner as to reveal the cost of this apparatus originally installed, together with the method of disposal of the charge upon its removal, no knowledge can be obtained as to the proper charge against the items.

At the present time, the tendency seems to be to regard the cost to reproduce new, as giving the most accurate knowledge as to what the value of the physical property of a corporation should be taken at. This quantity, if carefully obtained, will represent the outlay necessary for a competing concern to duplicate the service given by the corporation in question.

From the cost to reproduce new, the present value of the property can be determined by making the necessary deductions to cover depreciation or shrinkage in value during the time the plant has been in service. In thus

calculating the depreciation, whatever value the property may have when sold as junk is deducted from the cost to reproduce, it being considered that the junk value does not depreciate. The remainder is called the "Wearing Value" and upon this the depreciation is figured. The difference between the Wearing Value and the Depreciation is called the "Remaining Wear." The sum of Remaining Wear and Junk Value gives the Present Value.

In making an appraisal, the information sought will depend upon the reason for which the appraisal is made. There are four reasons for which appraisal may be made :

- I. Reorganization or Stock Issue.
- II. Bond Issue.
- III. Rate Determination.
- IV. Sale of property.

I. In the case of reorganization or stock issue, it becomes necessary to determine whether or not there be sufficient physical property to protect the purchasers of the stock. Therefore, the determination of Present Value is essential.

II. In the case of a bond issue, the essential fact to determine is, to what use the money derived from the sale of bonds is to be put. This necessitates a determination of the Cost to Reproduce, together with Depreciation. It must be ascertained that the growth of the service is sufficient to warrant the increase of capital covered by the bond issue, and that the money so derived is actually put into plant and property, and not used for maintenance or the payment of dividends.

III. In the determination of allowable rates, the point to be ascertained is whether or not the corporation in question is earning a fair income on the capital invested. In view of this fact, it is important to determine the original cost. Since the net income depends upon the gross income and the operating expenses, it is necessary to inspect both of these accounts. This naturally leads to a determination of the cost to reproduce, depreciation and present value.

IV. In considering a sale, the question to decide is, what is the market price of the property at the time the sale is considered.

The subjects Original Cost, Cost to Reproduce, Depreciation and Present Value having been touched upon in outline, it will now be necessary to consider the component parts of which each one of these quantities is made up.

Original Cost represents the total expense of placing the company in a position to earn a revenue on the capital invested. This expense would naturally sub-divide itself into two division, the physical property with which the plant is equipped, and all other expenses necessary to enable this

property to be put to the use for which it was intended. The first sub-division is called "Tangible Capital"; the second, "Intangible Capital."

Tangible Capital can be again sub-divided into "Fixed Capital" and "Floating Capital," "Fixed Capital" being taken to mean capital which has an expectation of life in service of more than one year (exception being made of hand and other small portable tools liable to be lost or stolen); Floating Capital is taken to mean everything other than Fixed Capital.

Intangible Capital covers the expense other than that represented by Tangible Capital, which was necessary to enable the concern to start business. It may be sub-divided into that incurred during the development period, and that incurred during the construction period. It may be outlined as follows:

Development Period:

Rights:

Expense of development organization, legal and technical departments.

Cost of property owners' consents.

Capital:

Expense of development, organization, legal and technical departments.

Interest on development expenditures during the development period.

Rights:

Expense of permanent organization.

Initial payment for franchises.

Capital:

Permanent organization as above.

Payment to underwriters.

Interest on development expenses during construction.

Construction Period:

Interest and taxes during construction.

Tangible Capital being represented by the physical property in possession of the corporation in question, can be determined by inspection. In so doing, the information should be obtained in such a way as to reduce the subject to questions of fact. For example, the land areas can be measured; the dimensions of the buildings and the materials of their construction can be ascertained. Similarly, the number and capacity of the generating station units can be determined by inspection, so that when the survey of the tangible property has been completed, the information is in such shape as to leave no room for questions of expert opinion.

Intangible Capital, as may be seen from the statement of the items which go to make it up, can not be determined in the same manner as Tangible Capital. Some information may be obtained from the records of the corpora-

tion covering the development period; but, be these records kept never so well, there will be found very few reliable methods of checking the information obtained from them. Comparison may be made with similar records of other corporations, but after all, the whole matter will hinge on the question of expert opinion. This uncertainty as to the accurate cost of Intangible Capital offers one obstacle against the accurate determination of the Original Cost.

In calculating the Cost to Reproduce, it is evident that some consideration must be given to Intangible Capital, since it represents part of the cost necessarily incurred by the corporation under consideration in order to put itself in a position to do business. This item taken together with the Cost to Reproduce the Tangible Capital represents what is sometimes called the "going concern value."

In calculating the Cost to Reproduce the Tangible Capital, proper unit prices can be applied to the items found to exist upon inspection. In placing unit prices, fluctuations in market values should be kept in mind. To guard against giving the corporation undue advantage of an unusually low market at the time of construction and an unusually high market at the time of appraisal; or to prevent putting it to the disadvantage of an unusually high market at the time of construction and a low one at the time of appraisal, it has been decided to take as unit prices, an average of 5 years, dating back from the time of appraisal.

To this Net Cost calculated in the manner described above, are added percentages to cover the contractor's profit, and the cost of engineering, administration and superintendence. The magnitude of these percentages will depend upon the nature of the work and the manner in which it is performed. In cases where the bulk of the construction work is planned and executed by the contractor, the percentage allowed for engineering by the corporation will naturally be smaller than would be the case where the corporation does its own planning. In some cases, both the contractor's profit and the engineering expense appear in the contractor's bill, the corporation's account showing only a small charge for superintendence and administration.

On the other hand, where the corporation employs its own engineering force to plan the work in detail, draw specifications and inspect the work of construction, the allowable percentage for these items will necessarily be higher than would be the case when this work is performed by the contractor. Concensus of opinion seems to have fixed the allowable percentage for contractor's profit at 10% and 15% for engineering, superintendence and administration.

In determining the Present Value, the question of Depreciation and Scrap Value must be considered. Depreciation might be defined as the shrinkage

in value due to wear, obsolescence and inadequacy. It is a recognized fact that any manufactured article will depreciate in value with age, where age brings into play one or all of these three factors. One method of determining depreciation is to take the quotient of 100 divided by the life in years. This method assumes that the item in question will be made use of during its life, and when this expires will be replaced by a new one.

If apparatus were thus actually maintained in service until worn out, and an accurate knowledge of its life thus obtained, the true depreciation could be calculated by this means. As a matter of fact, very few items which go to make up the working mechanism of a public service plant are actually "worn out." They are rather superseded by newer types, which are calculated to be more efficient, or which have a capacity for handling a larger volume of business. Take, as an example, the rails used by a street railway company. At the time when the company started service, horses were the motive power, while the cars were the old type of four wheelers used in this class of service. The rails were correspondingly light. The road becomes electrified and heavier cars are put into operation; consequently heavier rails are needed. The old horse car rails, be they never in such good condition, are replaced by heavier ones. Again, as traffic grows, the cars must be made larger to meet it, and the rails must again be replaced by those built to withstand the heavier shocks not only, but better suited to afford a return circuit for the increased flow of current. The same process is followed out with the car bodies and equipment, not only, but also with the power stations and power station equipment. There are street railway companies in many large cities that have power station buildings equipped with complete steam plants and belt-driven railway generators of the 550-volt direct-current type, lying idle, because superseded by newer and more efficient apparatus and buildings to accommodate it. In many cases, this idle apparatus is in excellent state of preservation.

Nevertheless, it must be conceded that apparatus tends to "wear out," even if it never actually does so; and that its value shrinks with age and use. If the amount of this shrinkage due to wear could be accurately determined, and if the length of time required for supersedure could be calculated accurately, the problem of depreciation could also be determined very accurately. Unfortunately, this condition does not exist. The wearing life can only be guessed at very roughly; and the length of the period before supersession takes place can only be guessed at even more roughly.

Some authorities consider that a piece of apparatus properly maintained does not depreciate in value so long as it performs the functions for which it was designed, and that it, therefore, should be carried upon the capital account at the original cost. They argue further, that, therefore, no fund

need be set aside from year to year to cover this shrinkage, considered by those who hold a different view to exist.

The danger in this theory lies in the ambiguity of the meaning of the word "maintenance." Maintenance may be taken to mean the labor and material necessary to keep in working order, those parts of a plant "*usually considered liable to trouble*." Or it may be taken to cover, in addition, the cost of repairs to the whole plant. It may even be enlarged to cover reconstruction. Again, if when repairs are made or reconstruction carried on, the defective items are replaced by items of the same type, then nothing is done to cover the shrinkage due to obsolescence, and inadequacy. Returning for a moment to the meaning of the word "maintenance," let us see what effect it has upon the subject. If this item is taken to mean the keeping in working order of those parts of a plant *usually considered liable to trouble*, it will cover in the case of a railway company, the cost of labor and repair material of the generating station force, that of the force in the repair shops, that of the track department, and that of the line department.

If the maintenance department be properly organized and equipped, the work performed by it from year to year and the consequent cost will be sufficient to repair all so-called "necessary trouble," itself a very elastic term. It will not, however, be sufficient to take care of the unusual wear and tear, which can not be noticed as it accumulated, and damage due to accident. As evidence of this fact, many corporations have to open, from time to time, a repair or reconstruction account, to cover this class of deterioration.

As proof of the above statement, it will be well, at this point, to inquire how the knowledge that replacements are necessary, is obtained. Take, for example, a pole line. The inspector goes over the line periodically prodding the pole to determine the nature of the wood, and ordering replaced all those that are shown to be defective by this means. There will be a number of poles, however, that will have developed "hollow heart" in the meantime, and which have escaped his notice. In this case, the cost of maintenance on the pole line will cover only the replacements ordered by the inspector, although that same line contains many poles that have depreciated unnoticed. A heavy sleet storm, with unusually high wind, brings the depreciation of these poles to light, with the result that a reconstruction account is opened for the purpose of covering the cost of repairing the damage.

It seems evident, therefore, that no matter whether a plant is maintained properly or not, in the ordinary acceptance of the term, there will always be a certain amount of depreciation which can not be detected until breakage occurs, and against which it is always necessary to provide financially.

Taking obsolescence and inadequacy into consideration, no maintenance

account, no matter how cleverly worked out, nor no matter how broadly it covers the cost of replacement due to wear and tear, will provide for replacement due to these two causes. In most cases, it is impossible to estimate with any degree of accuracy, the useful life of a piece of apparatus before it becomes obsolete or inadequate; because many unknown factors enter into the problem. The useful life depends upon the growth which in most cases is difficult to predict. It depends upon the activity with which more efficient apparatus is gotten out; and lastly, the taste and fancy of the man who decides upon the substitution of apparatus for the corporation.

In view, therefore, of the above considerations, it is evident that a fund should be set aside to provide against depreciation due to invisible deterioration and that due to the liability of supersession. It can be considered that since the replacement of physical property goes on constantly, a time will come when all the original apparatus will have been withdrawn from use. When this cycle has been completed, the total depreciation at any one time will be 50%. This condition only obtains strictly with such pieces of apparatus as are being constantly replaced by others of the same type, as, for example, rails.

In this case, if the original cost be plotted on the vertical scale, and the life in years on the horizontal, the amount annually set aside to cover depreciation will be represented by the distance between a line joining these two points and a horizontal line drawn parallel to the axis of age at a height equal to the original cost. If obsolescence and supersession are taken into consideration, the line of depreciation will no longer be straight, but will curve with its concavity downward, intersecting the axis of age, at a date earlier than would otherwise be the case. Here the vertical distance between the straight and the curved lines represents the additional sum to be set aside to cover these other two factors.

If the money set aside to cover depreciation be put out at compound interest, it will create a sort of sinking fund, which should equal the original apparatus when its useful life has been reached. The amount so set aside may be calculated as follows:

D=Rate of depreciation expressed as a percentage of the first cost.

R=Rate of compound interest.

n =Assumed life of apparatus in years.

B=Ratio of value of old material to that of the apparatus when new.

Then

$$D = \frac{100R(1-b)}{(1+R)^n - 1}$$

For example, suppose we want to put a small power plant at a mine, which we believe will be exhausted in 10 years, and the plant will cost

\$5 000. Assuming that the scrap value of the equipment will be \$750 when its useful life is ended, how much must be set aside each year at 3% compound interest to amount to \$5 000 minus \$750, or \$4 250 at the end of 10 years. In this case

$$B = \$750 \div 5\,000 = 0.15;$$

hence

$$D = \frac{100 \times .03 (1 - .15)}{(1 + .03)^{10} - 1} = \frac{100 \times .0255}{1.344 - 1} = \frac{2.55}{.344} = 7.41\%$$

and 7.41% of \$5 000 = \$370.50, which if set aside annually for 10 years at 3% compound interest will equal \$4 250 at the end of that period.

The possession of Scrap Value is necessary to determine the Wearing Value from the Cost to Reproduce, as has already been stated. Its method of determination will, therefore, be considered briefly. The one determining factor governing scrap value is the cost of the labor necessary to be performed by the junk dealer in order to get the material into marketable shape. It is, therefore, essential to consult the junk dealer upon this subject; an itemized list should be made up, stating the weights of the various materials to be considered, together with a statement of the sizes of the parts and all the information necessary for him to calculate the labor item. Where more than one junk dealer exists in the locality, all should be consulted and an average of their estimates taken as a fair value. When this has been done, the work of obtaining scrap value may be considered finished.

DISCUSSION.

Mr. WILDER.—Depreciation is the most difficult part of an appraisal to determine or estimate. It is easy enough to look at an engine and say that it will last about 20 years, but that is very largely an opinion, as there are very little reliable data at hand on which to base such estimates.

In view of the fact that the Governments of the various States, as well as the United States, are beginning to prescribe how public utility corporations shall be organized, and what kind and quality of service they shall render the public, as well as the recompense they shall receive for their services, it becomes necessary to obtain some idea of the value of their plants.

There are several values to be considered, namely:

The Original Cost to the company.

The Cost to Reproduce a plant of equal capacity and efficiency.

The Present or Depreciated Value.

The Original Cost can only be obtained from the company's records.

The Cost to Reproduce of the Tangible or Physical Property may be obtained fairly well in the manner Mr. Boyrer has outlined. The Intangible or Organization Cost is extremely difficult to determine, as there are almost no reliable statistics available on this subject. It has been variously estimated at from 15% to 50% of the Cost to Reproduce of the Physical Property.

The Present Value of the Tangible Property may be determined partly on some elapsed life basis and partly on the basis of obsolescence of the apparatus involved in the plant. It is impossible, however, to accurately or perhaps even approximately estimate depreciation which has or will take place, due to obsolescence, as such depreciation is dependent largely on the progress of the art, and to a lesser extent, on the growth of the business.

There are numerous instances of electric lighting plants built 10 years ago and equipped with reciprocating engines, which have been abandoned for the large turbine units. This could not be foreseen 10 years ago; neither can it be determined today whether the gas engine with its gas producer plant will displace the turbine and steam boiler within the next 10 years.

The question, therefore, as to what depreciation a company shall allow for obsolescence is one that has not and probably will not be answered for a long time.

Some companies do not consider it necessary to set aside any fund to meet depreciation, depending entirely on providing for renewals out of earnings, and that so long as a piece of apparatus can be used or operated efficiently, it should be carried on the books at its full value. As to whether such a policy is sound, depends somewhat on the size of the company.

To illustrate that point, suppose a street railroad company goes into operation with 100 cars, and has no occasion to materially increase the number. The life of a trolley car operating in a city like New York is from 18 to 24 years. If no fund is set aside with which to renew these cars, then at the end of 18 years, the company will have to draw very heavily on its earnings to renew practically its entire car equipment in perhaps 2 or 3 years. If, however, the company's business should increase very rapidly and they should purchase additional cars from time to time, then when the time came to renew the first 100, the annual earnings would be so large that the renewal of 100 cars during 2 or 3 years would not be a serious drain.

There are so little reliable data on the general subject of valuation and depreciation, that no fixed rules or procedure can be prescribed or followed. Each case must be handled according to the conditions found to exist. As we progress, however, information and data will accumulate which will undoubtedly shape policies and methods that will be more than individual opinions. Meanwhile, the more the subject can be discussed by engineering organizations and others interested in the subject, the more rapidly will these policies and methods crystallize into shape and become established precedents.

MR. MERRITT.—I don't think I could add anything to what has been said, Mr. Roberts. I think the subject has been pretty well covered.

MR. WILDER.—I do not agree with Mr. Merritt. I believe the subject can not be covered in so limited a time, and there is a great deal more that can be said on the subject.

MR. CHEVALIER.—I cannot offer anything of value, Mr. Roberts, on the subject, but it has always seemed to me that the method of obtaining depreciation in itself is rather fallacious, because the present value seems to me would depend a great deal upon the use to be made of it. For instance, if an apparatus is put in a plant for manufacturing an article or for electrical

work, and after a year of service you can say that its value for producing what it is intended to produce is practically the same as when it was put in, you can state it as an asset. If you try to dispose of that piece of apparatus, you could not realize what it cost, and if you wanted to charge off depreciation it would seem that it would be a much larger proportion taken off. Aside from that you can nowhere get the money for it that you could get in service if you keep on using it.

Mr. WILDER.—In determining depreciation upon a piece of apparatus, such as mentioned, it must be kept in mind that this apparatus is to be used for the purpose that it is being used—as for instance, an electric plant. The electric light plant has a certain value with the business that it does. If we take that business away at any time we simply have a pile of scrap which would only have a salvage value. Therefore, in determining a depreciation on a corporation like public utility corporations, I believe it is necessary to consider that it is going to continue doing the work that it is then doing. If you make an appraisal for the purpose of determining what the plant can be sold for, you have a sale basis on which you make the appraisal. If you are going to appraise it as present value and determine whether you are going to issue stock or bonds, you must assume that it is to continue with its present business.

Mr. OULD.—I am afraid, Mr. Roberts, that I have nothing to offer just now. I am much interested in depreciation. It is a thing I have had to give some thought to always, for it is certainly a very interesting one. Here is a thought which comes to me now which has nothing to do with public utilities, but which has a bearing on it, and since we have a number of gentlemen here whom I think can tell something about this, I would like to know how you reckon depreciation on a plant which has been given you.

You take, for instance, such a plant as the new public library. There is a plant which I understand has been practically given to the trustees of that institution by the City of New York. The trustees in a case such as that had to put up no money at all for it. The time will come when they will have to replace it—would that come under the same general law as those others which we have been discussing? That to me is an interesting one, because there are a number of plants which really fall under that category. For instance, you take such things as hospitals, schools, colleges and many of those things are given, and given in a funny way. I remember a circumstance in New York, where a gentleman in New York put up a great deal of money and didn't give a cent to run the institution or to take care of depreciation or maintenance. I ask the question for information, for I have given considerable thought to it in trying to arrive at the correct amount to set aside for just such things.

Mr. BOYRE.—I think it could be handled the same as the other cases. Somebody has to pay for the building. Handle it just the same as the others.

Mr. OULD.—Setting aside money, or having to get an income, or taking a portion of the income for depreciation, or setting aside for depreciation, how can you reckon in as percentage of original cost when you did not pay it?

Mr. WILDER.—I think you have to assume whether you will reproduce it or not at the time it wears out, and if you are to keep it intact, you have to

provide some means of renewing such apparatus as it wears out. It would be better to put aside an amount each year. Take each piece of apparatus and get such data as you can on the life of this apparatus, sum it up and set aside an amount each year, and from it you could draw from time to time to renew the parts as they come due. In doing that you could invest that part not needed until the latter part of the plant's life at compound interest, which will help to produce the amount required to renew it, and that will reduce the amount you have to set aside each year.

The first cost of a plant has been determined wherever possible, and not only the first cost, but the value of the plant from year to year as the time goes on, in order to determine if possible whether the company has been able to pay reasonable dividends on their investment. If they have not, in the opinion of some, the company is entitled to capitalize the amount they were unable to pay in dividends, in order that the investor may get a fair investment. I know of only a few cases where it has been possible to determine the first cost. The ability to determine the first cost only in a few cases has been able to be done. A great many companies carry on their books apparatus that has gone out of business long ago and have been renewed out of their earnings, so that is one of the difficulties in determining the first cost. In determining the cost to reproduce for purposes of rate making or for stock or bond issues, the original cost is practically disregarded, except in some cases for the purpose of guiding you as to the prices that you are paying for it. A fair way seems to be to figure up the cost of reproduction, based on an average price of material and labor during the preceding 5 years, so that you can give the company the benefit of the fluctuations of the market. The item of first cost has been so far a very indefinite value, and has been used very little except where the company's records have shown clearly what the cost of the property has been from time to time. In getting the present value, you sometimes includes apparatus that you do not include in the cost of reproduction. If you have certain apparatus lying idle in your plant, or setting out in the yard ready to be sold, if you are to reproduce the plant today you would not reproduce those articles. But if you want to determine whether the company can safely issue bonds, that apparatus is considered as an asset so long as it stands there, and on it you will put a salvage value and include it in the present value.

Mr. ———.—Depreciation a railroad system: The main line track would wear out in 10 years and have to be replaced, would it be right to allow 10% for depreciation per year during the 15 or 20 years, or depreciation on the average or whole thing or separate division?

Mr. WILDER.—There is a theory on the subject of track somewhat different from the general subject of depreciation on apparatus that has been used, but it can be applied only to a large system. Take the Brooklyn Rapid Transit System, for instance—each year that company is renewing track. At the end of a number of years, it will have completely renewed all of the track, and that portion which was done first will be worn out and ready to be renewed again. With this process of renewal going on continually, it can be seen that there will be stretches of track in all states of depreciation, from new track just constructed, to worn out track just to be

reconstructed, and the average or present value of the track will be one-half of the cost to reproduce.

This theory may be stated as follows: Any part of the equipment of a plant which in the process of maintenance becomes completely renewed, and which has been in operation long enough to pass through one cycle of life, has a value of one-half of its cost to reproduce.

This theory can only be applied, however, where, in the process of renewal, the renewed parts are of the same dimensions, capacity or value. To illustrate: if in renewing a piece of track, a 100-lb. rail is put in place of a 60-lb. rail, then there is a capital addition to the track equal to the difference between the value of a 60-lb. rail and a 100-lb. rail. In such a case as this, the 50% theory will not give correct results.

Mr. CHEVALIER.—What is the practice of investigating depreciation values in extensions to plants, and what means will be taken in keeping track of that in accounting. Some plants will take depreciation fund or sinking fund and interest, or putting it out at interest and will invest that and use it to the replacing of the fund. I would like to know what is your opinion as to the propriety of that practice?

Mr. BOYER.—I don't know that I have ever seen any condition of that kind, anything of that sort.

Mr. WILDER.—That is a perfectly legitimate way of using a depreciation fund. It would not be reasonable to expect a company to put such a fund out at interest and then have to go out in the open market to borrow money to carry out its business.

Mr. CHEVALIER.—What then is the system of bookkeeping?

Mr. WILDER.—The present system is prescribed by the Public Service Commission and if carried out will take care of it; the requirements are very strict, and the reports are very carefully examined. It seems to me it ought to take care of that. If it shows where this depreciation fund is invested, it seems to me it takes care of it. If the fund is drawn on frequently for repairs, at the end of the year, by an investigation with the present system of bookkeeping, it can easily be taken care of.

Mr. CHEVALIER.—What would happen if earnings on the extensions built with that money would pay the interest and fail to produce enough to pay interest on the depreciation?

Mr. WILDER.—I don't think you could assume that the extensions would necessarily pay for themselves. Take a railroad for instance: you can build a branch to a railroad into a new section which for several years it could not pay for itself, but it is a form of future development and which will pay eventually.

Mr. CHEVALIER.—You have to pool the whole thing?

Mr. WILDER.—You would keep track of the actual tangible property that you put in the plant with that money, then when you need money for renewals you have got this tangible property against which you can issue bonds because it has not been capitalized.

BROOKLYN ENGINEERS' CLUB.

No. 105.

ALL METAL CONSTRUCTION OF DOORS AND TRIM FOR FIREPROOF BUILDINGS, ETC.

BY WILLIAM J. GRINDEN.

PRESENTED OCTOBER 12, 1911.

In the development of modern buildings architects and engineers are obliged to consider the absolute necessity of producing an entirely fireproof structure.

All inflammable materials, such as wood, etc., are eliminated. By this is meant, walls, floors, trim, etc., and as doors and windows are most important parts of such buildings it seemed absolutely necessary to obtain them of a fireproof character also.

The first step made in this direction for doors and trim was the use of wood treated chemically which served to make it non-inflammable. It is used to some extent in buildings and ship construction, but has proven to be somewhat of a makeshift, as it is not only costly but the character of the chemical treatment has a tendency to destroy the wood fibre and to render it, by process of disintegration, useless. This statement, however, is not based on any personal knowledge of the author of this paper. It has come to him through reports made by users of the material and must, therefore, be accepted only as hearsay. Whilst fireproof wood is still being used there is no doubt that in some quarters its use has been discontinued and a construction mentioned later in this paper has been substituted for it.

The United States Government, for example, has adopted all metal construction in place of it for its naval vessels, and many architects and engineers have followed the same course.

Attempts have also been made to produce doors and trim of a plastic composition formed under pressure in dies, but the results thus far have not been satisfactory.

The next advance in the line of fire proofing was the use of wood covered with a light metal and which is known generally as "Kalamein" work. This process was one of evolution; the first attempts being the tin-clad wood doors demanded by the Board of Fire Underwriters. Doors made in this way are satisfactory for mill and factory construction but on account of their inelegant appearance could not be used for office buildings, hotels, or similar structures. About the year 1893 a manufacturer produced a door made of wood with three panels and covered it with metal. It was a great improvement in appearance over tin-clad doors. Later on other manufacturers im-

proved the process and made not only better doors but also made the moldings required in same, as well as in the trim, of wood with thin metal wrapped closely around it, which enabled them to give a more artistic appearance to the finished product.

The test of time, however, showed plainly that the Kalamein product did not solve the difficulty, as great quantities of work proved to be unsatisfactory owing to the wood core shrinking or warping, distorting the metal covering and frequently rendering it impossible to open or close the doors. Another very serious objection to it is on account of rust. Lumber used in the manufacture of this product contained frequently moisture and other ingredients which attacked the inner side of the metal covering and, in a short time, holes were made in the surface, joints would open and the final result can easily be imagined. A prominent manufacturer and user of this class of work told the author only a few days ago that, in his opinion, a Kalamein door would last only 2 or 3 years. The use of wood as a filling agent permits of so many abuses that the Board of Fire Underwriters now compel manufacturers of even the tin-clad doors to submit not only their finished product for inspection but also to submit each section of same before they will furnish the underwriters' labels.

These difficulties led manufacturers to seek some better method and their efforts resulted in the development of the modern product known as "hollow metal construction"; or, as it is sometimes called, "all metal work." Some of the makers of Kalamein doors experimented with the newer method and in a measure were successful after much effort and loss. Up to a year or two ago there were only 2 or 3 concerns able to turn out satisfactory work. There are now many buildings in this country in which the all-metal construction is installed throughout and architects and engineers are beginning to appreciate the great advantage it has over all others.

The method employed in the all-metal construction is as follows:

A heavier gauge than is required in Kalamein work, either of steel or other metal, is used.

When steel is specified a grade of low carbon acid open hearth material, known commonly as "Furniture Steel," is employed. It is made by the cold rolling process and after annealing and pickling it is patent leveled to remove all waves incident to rolling, as it is imperative that absolutely flat surfaces be obtained. The thickness of the steel varies, depending on the engineers' specification. No. 20 gauge (.035-in. thick) is commonly used in doors required by builders of steel cars and No. 18 gauge (.049-in. thick) is the size frequently used for office buildings, etc.

There are different methods of construction, all of which are patented and they vary somewhat in detail, but they accomplish the result desired.

which after all is the main thing. To describe these different methods would occupy too much time and would burden you with uninteresting matter.

It may not be out of place to describe briefly one of the methods of manufacture with which the author is familiar. The stiles are formed in dies. The inner edges of the stile being made with open grooves or slots into which are locked the rails and other parts of the door. The rails are formed in a manner similar to the stiles and in addition are made at both ends with projecting flanges which lock into the stiles. As no wood cores or fillers are employed, light steel channels are used as stiffening or bracing members and

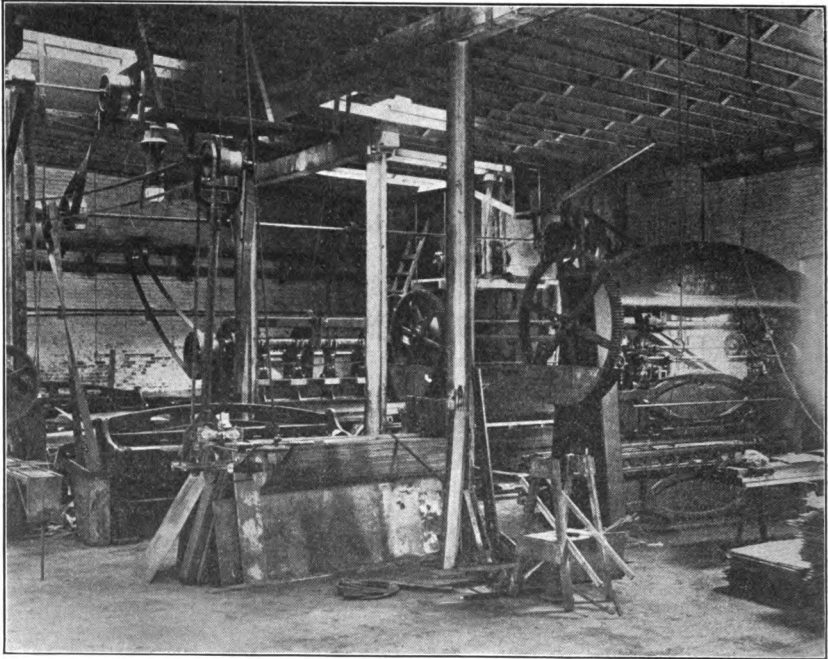


FIG. 1.—VIEW OF PRESS SHOP.

are locked into the recesses made to receive them in stiles and rails. In the stiles these run vertically and in the rails horizontally. Moldings required in door construction are formed to any contour by means of rolling dies set in a rolling machine and draw bench. The original steel for moldings is of cold rolled quality and is purchased in coils of about 200 to 300 ft. in each. These coils are placed into position in the rolling machine and the end of the coil is inserted between the dies and is gripped securely by the draw bench dog. The number of dies vary with different shapes. Some moldings of simple contour can be made with 2 pairs of dies, whilst more

complicated forms require 5 and sometimes 6 sets. These dies are designed to permit the metal to form into shape in the easiest manner possible so as to avoid any fractures. As the steel is drawn cold this is quite necessary and it is also necessary to have the material soft and ductile. It is quite possible to form any shape of molding now made in wood, of steel and the lines of the various curves or forms of it can be made equally sharp and clean. After gripping the end of the coil firmly the "dog" is locked into the draw bench chain, which travels at various speeds dependent somewhat

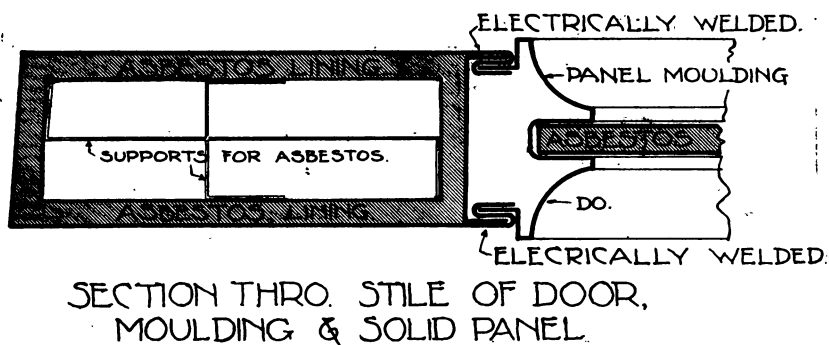


FIG. 2.

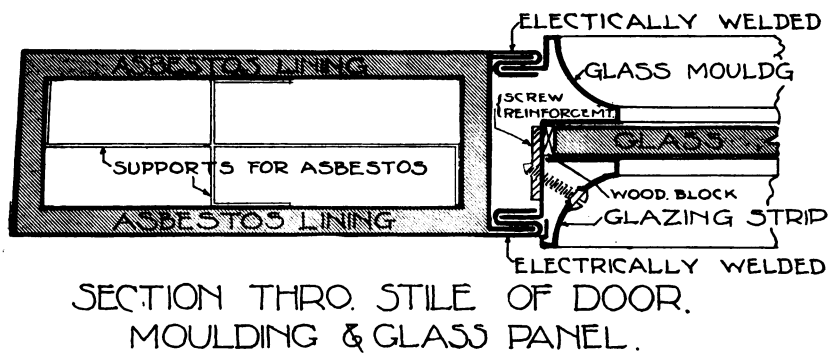


FIG. 3.

on the shape and on the thickness of the material used. The "dog" pulls the metal through the dies which revolve and form it to shape, and after reaching the length of molding desired it is sawed off and a new grip is taken for the next length. The gauge of the material used in making moldings is generally the same as the steel in the door. The moldings are then sawed to length, mitred, and are ready for further use. In making door moldings the inner edges are formed so that they can be locked into the prepared recesses of rails and stiles. The other part of the molding is

formed with an open slot suitable for receiving glass or solid panels. After the molding is locked into position panels are inserted. These side panels consist usually of two flat sheets of steel, cut to size, between which is glued a filler of composition or asbestos.

The use of the asbestos or composition filler is not necessary to obtain fireproof qualities, and in car work is seldom required. For buildings, however, many architects object to the metallic sound and require the manufacturer to insert some material to eliminate it.

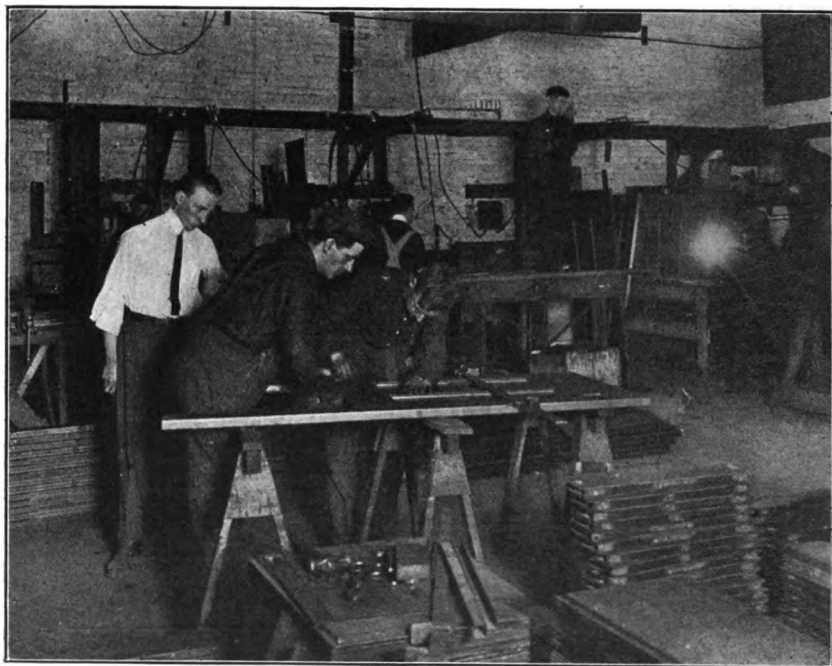


FIG. 4.—VIEW OF CORNER OF WELDING SHOP.

After the various parts of the door are formed they are assembled into complete shape and are ready for permanent fastening.

In the early stages of this industry makers riveted the parts together, but this was found to be objectionable; the steel shell of the door being very thin and as it was necessary to use rivets with flush heads their holding properties were much lessened. It was found that in service these rivet heads would move slightly and sometimes, under shock, would pull through and thus destroy in appearance the enameled finish. It was, therefore, necessary to find some means of uniting these parts together.

Electric machine spot welding was used for a short time, but owing to the uncertainty of permanent welds and the difficulty of keeping the various parts in perfect alignment while being welded, this process was abandoned. Acetylene and oxygen gas welding was brought in service and with some concerns is now employed. There is great difficulty, however, with the gas flame owing to the prolonged heat of it on the surface of the steel and the resultant tendency of warping it. The steel, being cold rolled, has in it all the rolling stress and very little heat is necessary to relieve these stresses and form slight waves in the metal. To the manufacturer this is his greatest trouble. It is quite easy to remove small blemishes or indentations, but it is very difficult to eliminate the waves.

Another method of welding and which has proven itself of great value is the electric system which the author succeeded in developing. Electric current is employed and a door, when assembled, is placed on a metallic table which is charged, the other pole is an ordinary cable carried over any distance, to which is fastened the welding torch and shield.

An arc is formed when contact is made and as the fusible electrode is drawn away, the arc intensifies, and the electrode melts rapidly, fusing the engaging surfaces instantly and permanently. By this process the heat is localized, and as each weld is chilled immediately the danger of warping is greatly reduced.

The doors are ground at the welded portions to remove all roughened surfaces and thoroughly cleaned and are then ready for the painter.

Priming coats of steel preservative paint are applied inside and outside, several coats of filler are used, each one being rubbed smooth with emery cloth; the body and grain coats and then the varnish coats are used. Each one of the various coats of paint and filler is baked in ovens and when finally finished the surfaces are rubbed with pumice and oil or water. Practically an enamelled surface is obtained and the danger of rust is eliminated.

One great advantage in all metal work is the entire freedom from wood, which permits of baking the paint at a high temperature which insures a much harder surface. Kalamein work, having the wood core, is painted and dried in the air which carries with it the danger of flaking, which is quite common to all metallic surfaces.

The application of the hardware is a very important part in door making. Under each hinge a heavy wrought steel reinforcing piece is welded to the stiles. It is drilled to receive machine screws and is more than ample to carry the weight of the door. The locks, door checks and other hardware parts are reinforced in a similar manner. It will thus be seen that the method described permits of making a door entirely free from rivets or screws in its construction, the only screws used being those required for attaching

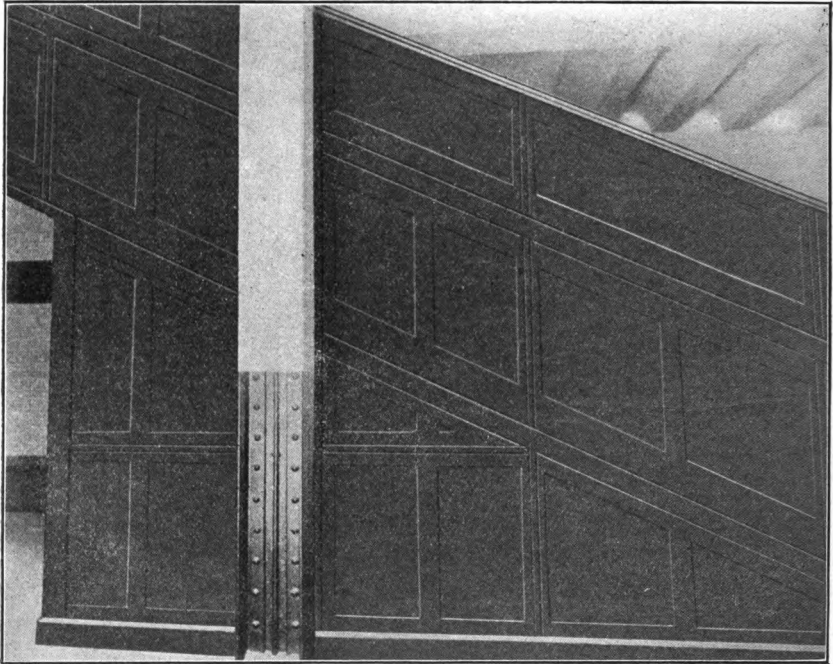


FIG. 5.—PANEL WORK OF ESCALATOR.

the hardware. Door frames and trim are formed in the draw bench previously described. The trim is welded at the mitred corners and is complete in itself. In erecting the trim, screws are used to fasten it permanently. The method of fastening the door and frame in the opening is: to use either a wood buck

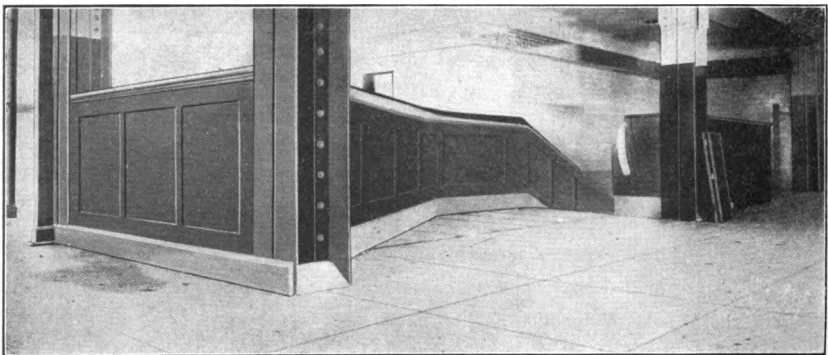


FIG. 6.—PANEL WORK OF ESCALATOR AT TOP OF STAIRS ENCLOSING THE MECHANISM OF THE SHUNT OR "THROW-OFF."

or frame anchored into the wall or a channel iron frame fastened in a similar way.

All metal construction is not confined to doors and trim alone. Interior finish, such as paneling or wainscoting and the like are made also. The exact contour of wood shapes are made and the skill of the painter permits the exact imitation of it so closely that the eye is deceived and only by touch can the substitution be detected.

Another advantage in all metal door construction is that when hung in position it does not change. There is no warping or shrinking incident to wood, or Kalamein work, and perfect freedom of operation is thereby obtained.

All metal construction is not confined to building work. Many of the prominent railroads have adopted, at least for passenger service, the all-steel car and it has been said by several prominent railroad men that no more wood cars would be built. All postal cars must hereafter be made of steel, to eliminate the danger of the destruction of mail matter in the event of collisions and subsequent ignition of the wrecked parts.

All of the modern battleships and many of the smaller naval vessels are equipped with all-metal doors and trim and it is quite unlikely that the Government will depart from this course, the advantages being so obvious.

DISCUSSION.

Mr. SOMNER.—In the matter of cost, how does the metal door compare with wood?

Mr. GRINDEN.—Very much more expensive, on account of labor.

Mr. SOMNER.—The really high class door?

Mr. GRINDEN.—A solid mahogany door would be cheaper.

Mr. SOMNER.—Oak doors?

Mr. GRINDEN.—A solid oak door is less expensive than a steel door. A good oak door cost from \$15 to \$18.

Mr. SOMNER.—Is the finish on the wooden door as permanent as on steel door?

Mr. GRINDEN.—No.

Mr. SOMNER.—The actual life of that door would be a great deal longer than a wooden door. The first cost is heavier; but the upkeep of that kind of trim would be much less?

Mr. GRINDEN.—Yes. From what we have seen so far a door properly erected and properly finished ought to last 20 years without any finishing at all; just a little oil.

Mr. SOMNER.—You try to safeguard against rust by covering with paint inside and outside, and it don't come off easily by any other means? No great jar disturbs it?

Mr. GRINDEN.—There is an amount of plastic nature in the paint we need for it. The paints we have used for priming have a sort of elasticity to it and we test it by taking a piece of stick and painting it and bending it



FIG. 7.—FREE STANDING TICKET BOOTH BUTTING TO WALL AND SCRIBED TO CEILING.

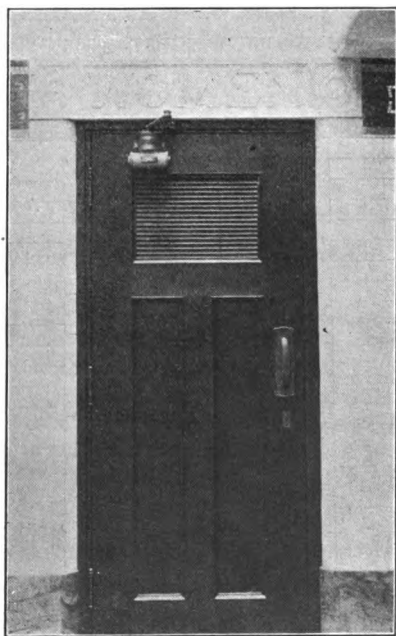


FIG. 8.—TOILET DOOR.

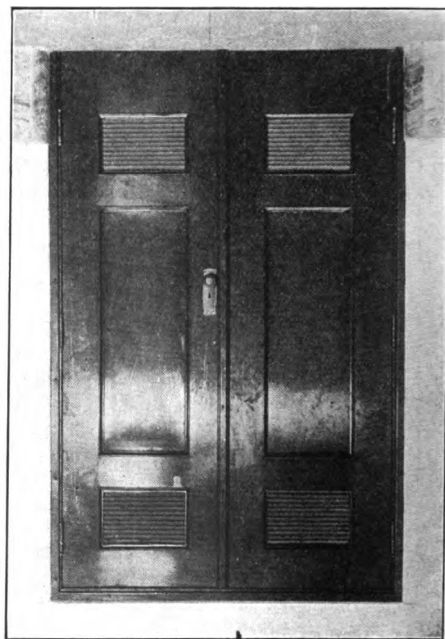


FIG. 9.—DOUBLE DOORS, WITH LOUVRE TOP AND BOTTOM, TO TRANSFORMER CLOSET AT END OF PLATFORM.

back and forth many times until we practically fracture the material, and until it meets that test we do not use the paint, and when the paint holds we feel that the door is properly painted and very little danger of door changing. At Centre Street and Canal we built the station for Mr. Moran, and that place being a subway is, of course, full of dampness; water is dripping in there and streams come in contact with the work. That work was done two years ago, and an examination of it shows it to be in as perfect condition as when it left our shop. No sign of rust. That is a very severe test. The engineers of the Public Service Commission, I believe, are very well satisfied with the type of construction.

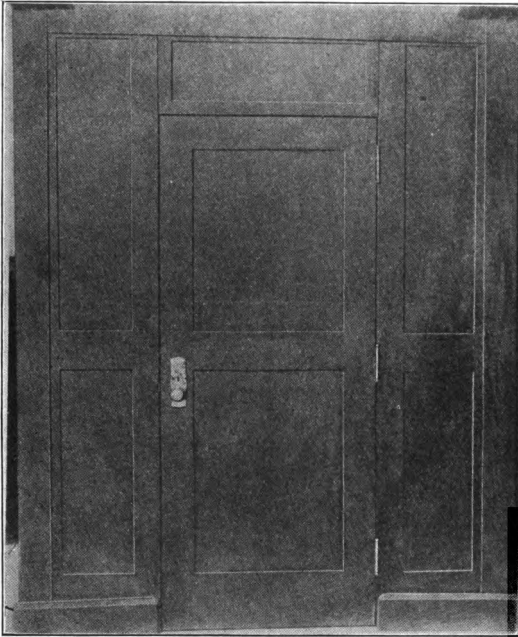


FIG. 10.—FRONT ELEVATION OF CONTROLLER CLOSET UNDER ESCALATOR.

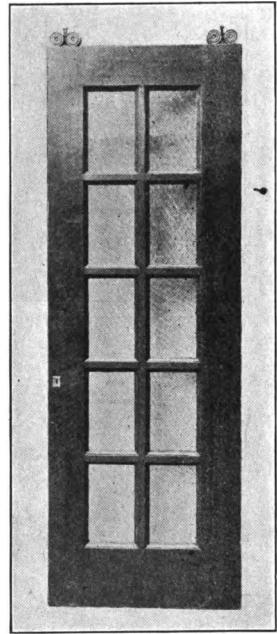


FIG. 11.—SINGLE ELEVATOR DOOR; RESIDENTIAL SECTION, NEW YORK CITY.

Mr. MACON.—A good many of us are interested in the hollow metal construction, but it is not clear to us how it has been made. In fact I have been told by some people that this is regarded more or less as a secret. Shops were not open for inspection.

Mr. GRINDEN.—It is not now.

Mr. SOMNER.—You speak of different kinds of doors used for marine work. Have any of those metal doors of the type you speak of been used for the navy?

Mr. GRINDEN.—All of the naval vessels have hollow wood construction. The Arkansas and many of the smaller naval-like torpedo boats, have the steel construction, the object being not so much in the reduction of weight as the necessity of preparedness in time of war. In warfare they eliminate



FIG. 12.—EXTERIOR WINDOW OF SUPERSTRUCTURE, DELANCEY STREET STATION, BRIDGE LOOP SUBWAY.

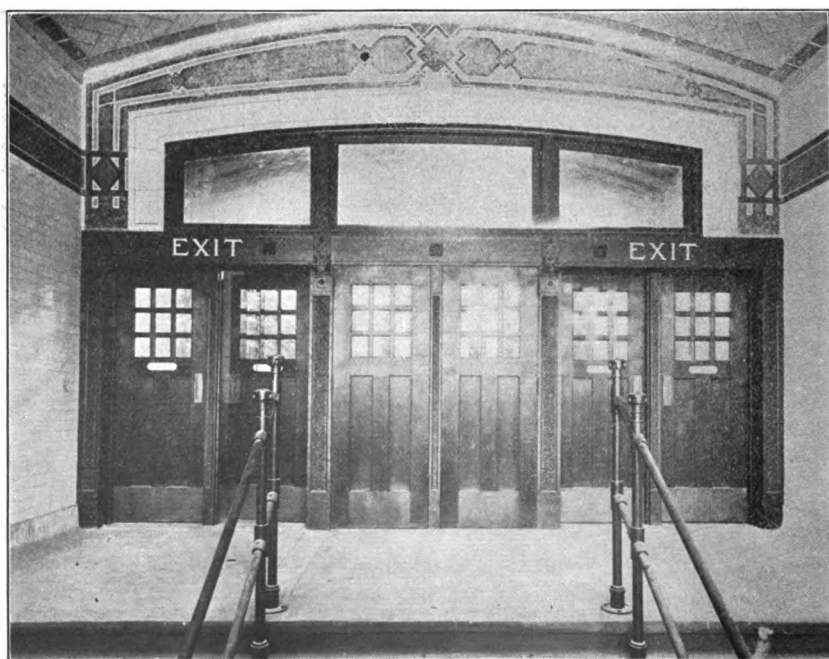


FIG. 13.—ENTRANCE DOORS, DELANCEY STREET STATION.

the wood. It is stripped right down to a working basis; with the steel construction, it is always ready; it does not have to be stripped down.

Mr. MACON.—You are apt to go beyond the critical temperature with acetylene?

Mr. GRINDEN.—Yes.

Mr. MACON.—If you use the so-called soldering in gas welding?

Mr. GRINDEN.—You can't use as much heat in soldering. You apply 300 or 400 and it will change the condition. It will expand about 1/32 of an inch to a foot.

Mr. ROBERTS.—You say the cost of the door is from \$35 to \$40, does that include the trim?

Mr. GRINDEN.—Yes. Of course the doors are made in different grades. On car doors the work is very much cheaper in construction and finish. The doors range anywhere from \$15 upwards. The cost of a highly finished door, including fancy trim on both sides, jamb and stop runs up the cost.

Mr. ROBERTS.—Do you have any trouble in all-metal doors warping from the heat?

Mr. GRINDEN.—No. The Fire Underwriters' test is to take the door and put it in an ordinary heating oven and give it a certain degree of heat, and then turn on a stream of water against it while it is hot, and if it warps or falls down at the trim work enough to let the fire go through, they do not give you a good report.

Mr. OULD.—Suppose one is moving a Grinden steel desk, a good heavy one, and the corner bangs up against a Grinden steel door; what happens?

Mr. GRINDEN.—It puts a dent in the door.

Mr. OULD.—Then what happens to the door?

Mr. GRINDEN.—You can not take the dent out. You could cut that piece out and weld a new piece in, and refinish.

Mr. ROBERTS.—That is one of the objections to metal lockers, that once you dent them, they are gone.

Mr. GRINDEN.—There does not seem to be any good way of getting rid of it or repairing it. The advantage of the metal lockers is that they are free from vermin. Vermin can not accumulate in steel. To show you how careful the Pennsylvania R. R. are in testing of any metal; they have a corps of inspectors, 18 or 20 men, skilled in that line, in different branches in their shops, and when an order is placed it is always subject to their inspection. When an order is placed for steel doors, the inspectors come to see what is going on, and none will be taken until every foot has been inspected. You have to put a door through a physical test, and their test is to put a vestibule door on horses and then put 750 lbs. across the center of it, and spring up and down and see if they can bend it. Then they pick up a door by a corner and drop it and see if they can not throw it out of alignment. When the door will pass their tests they are satisfied to take our work.

Mr. ROBERTS.—In the ordinary method of finishing doors, the first thing is to smooth it with cement to fill up cracks?

Mr. GRINDEN.—It is all cleaned with pumice and wiped clean and rid of any metal surface mark of rust or other blemish, and after that is done there is always little indentations in the door incident to manufacture, so we use a plastic material, which is put on about the same as butter spread



FIG. 14.—BOTTOM NEWELS AND PANEL WORK OF ESCALATOR STAIRWAY.

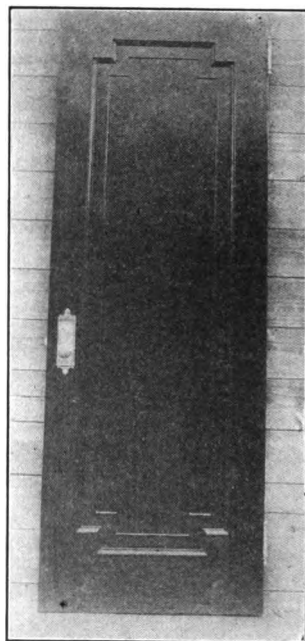


FIG. 15.—SINGLE PANEL DOOR DESIGNED TO CONFORM TO STYLE AND FINISH OF MAHOGANY DOORS IN SAME BUILDING.



FIG. 16.—FREE STANDING TICKET BOOTH, OCTAGONAL SHAPE, COMPLETE IN ITSELF.

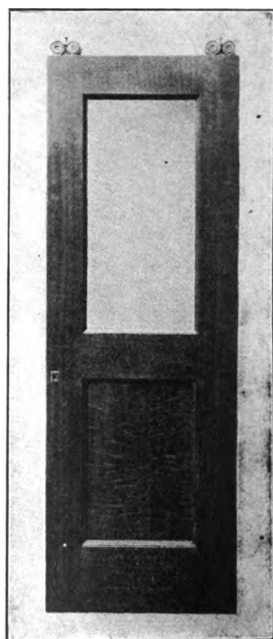


FIG. 17.—SINGLE SLIDING SASH DOOR; RESIDENTIAL SECTION, NEW YORK CITY.

on bread and when that paste is on it becomes like smooth-on cement, and that is rubbed smooth and a second coat applied. That is rubbed smooth again, then the priming coat is put on top of that.

Mr. ROBERTS.—Is that Japan?

Mr. GRINDEN.—Coat of paint made specially to cover steel.

Mr. ROBERTS.—You bake the cement after smooth-on? You bake it twice?

Mr. GRINDEN.—Yes.

Mr. ROBERTS.—First thing, you cement prime coat; you bake that, and then another coat of Japan?

Mr. GRINDEN.—Japan is not used.

Mr. SOMNER.—What is used next to priming coat?

Mr. GRINDEN.—Body coat.

Mr. ROBERTS.—How many coats on that altogether?

Mr. GRINDEN.—Seven coats.

Mr. ROBERTS.—Chromium paint?

Mr. GRINDEN.—Yes.

Mr. ROBERTS.—One or two coats of that?

Mr. GRINDEN.—Two.

Mr. ROBERTS.—Then you have two coats of varnish?

Mr. GRINDEN.—Yes. At least two, and sometimes more. The reason that we have to use so many is it gives something to work on for rubbing down.

Mr. ROBERTS.—Each coat rubbed down?

Mr. GRINDEN.—Yes.

Mr. ROBERTS.—Last coat rubbed down?

Mr. GRINDEN.—With pumice water and piece of felt.

Mr. SOMNER.—Almost a piano finish?

Mr. GRINDEN.—Yes, practically.

Mr. VIOLA.—Do you make fireproofing doors? What kind of doors do you make for fireproofing plants?

Mr. GRINDEN.—Any ordinary metal door suited to use consisting of three layers of wood placed in different positions and that is all tiled together. There is used on top of that a certain grade of tin and the metal is lapped over that to avoid explosion when exposed to heat. For ordinary use it is good enough, but if you want to have anything more ornamental and still fireproof you have to have hollow construction. The average factory door is tin plate door. The difficulty in using wood and metal is, they are two opposite materials; one is susceptible to change in water moisture and dryness, and the metal does not change. I have been through the experience of using tin clad doors. Under heat they will explode, and the gases inside become so hot that they will burst open.

Mr. SOMNER.—Wood springs; how much change is there in the size of the ordinary sheet steel door?

Mr. GRINDEN.—It is reckoned that the door will expand under 300° heat $1/32$ of an in.; $1/16$ of an in. under 600°, and at almost melting point $1/2$ of an in.

Mr. SOMNER.—Does it not take many degrees to expand?

Mr. GRINDEN.—You take a cube 1 in. sq. and then heat it, it does not

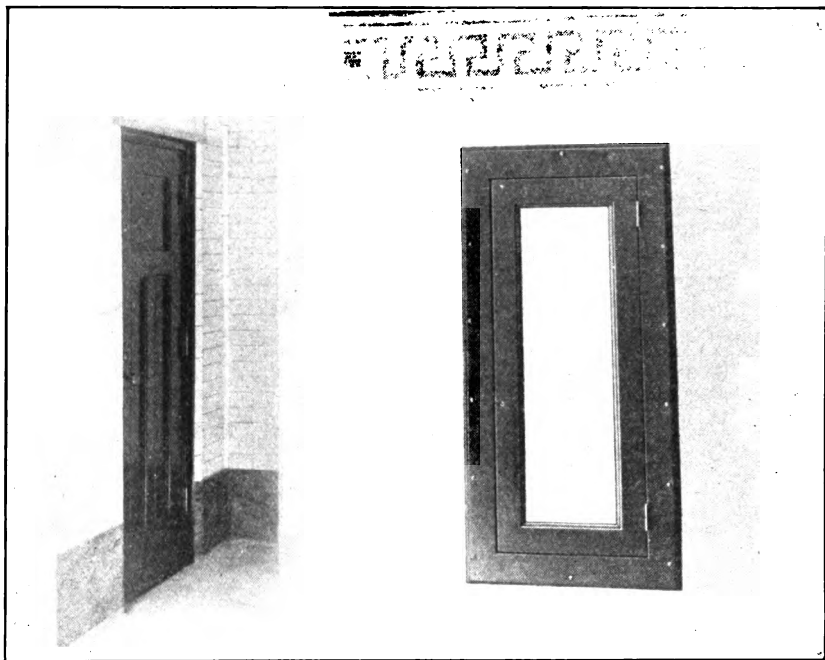


FIG. 18.—PANEL BOARD DOOR AND FRAME.

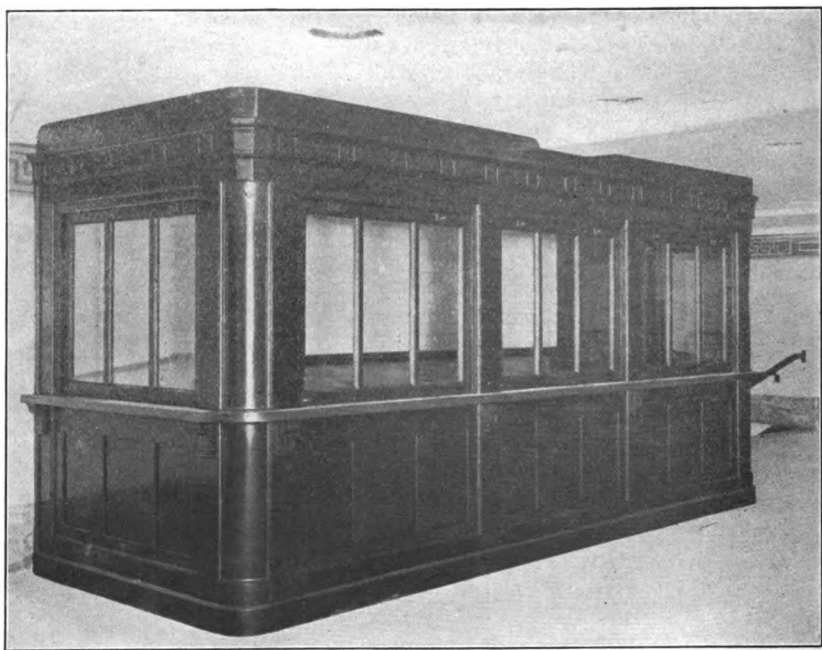


FIG. 19.—FREE STANDING NEWS STAND—BUTTING UP TO WALL AND SCRIBED TO CEILING.
THIS ALSO INCLUDES CASH DRAWER, COUNTERS, CUPBOARDS, DRAWERS, ETC.

change. The heat applied to a piece of steel in tempering does not change its size.

Mr. MACON.—In case of panels of doors, is the inner sheet of metal in addition to asbestos? is that strengthening?

Mr. GRINDEN.—The two sheets form the panels themselves; that is, two sheets of steel form the panel and in between is placed asbestos. Before the panels are put on, the sheets of steel are taken and glued together under pressure. We use melted glass for glueing the asbestos to the steel. We find that that is the best agent for preserving the steel.

Mr. MACON.—The preliminary coat of painting, is that one of the lead paints?

Mr. GRINDEN.—I really could not tell. The best paints that we find are made by a concern in Newark, Platt & Conklin paint. The only way we have of telling, is in the simple crude way of testing by bending it back and forward to see if we can crack that paint.

BROOKLYN ENGINEERS' CLUB.

No. 106.

HYDRO ELECTRICAL INSTALLATION, CHATTA- NOOGA AND TENNESSEE RIVER POWER COMPANY, HALES BAR, TENN.

BY GEORGE A. ORROK, MEM. B. E. C.

PRESENTED NOVEMBER 9, 1911.

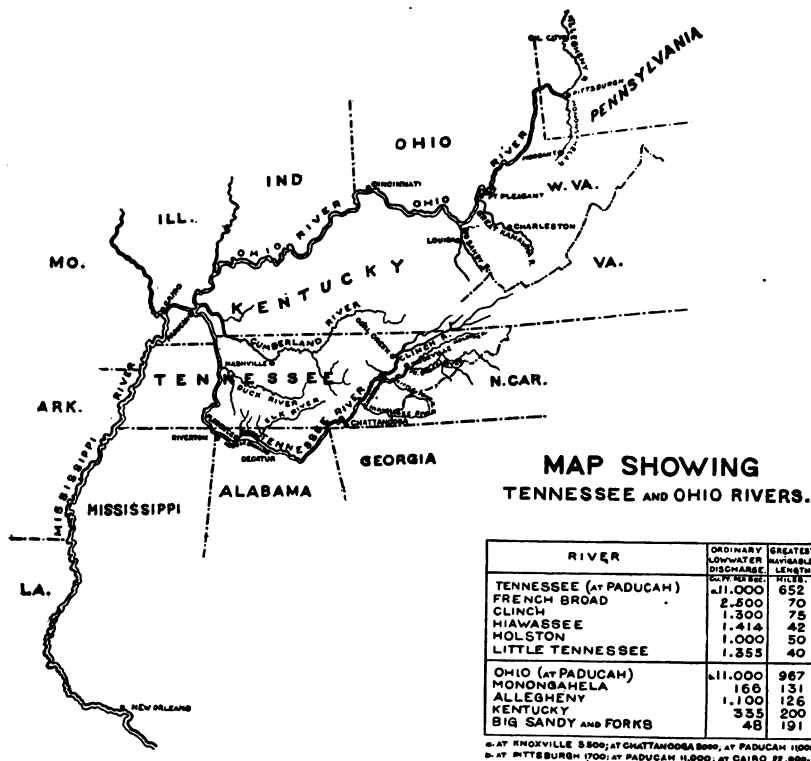
The Tennessee River is formed by the union of the Holston and the French Broad rivers which rise in the mountain regions of North Carolina and Tennessee and flow in a southwesterly direction through Tennessee into Alabama and then in a practically northerly direction back again through Tennessee, joining with the Ohio at Paducah.

The total length of navigable water ways formed by the Tennessee and its tributaries is about 1 300 miles. The drainage area is about 44 000 miles. At Riverton and Muscle Shoals the obstructions to navigation have been removed by a system of canals and locks so that a 5-ft. depth of water is available the entire year from Paducah to above Muscle Shoals, a distance of nearly 300 miles.

Between Muscle Shoals and Chattanooga the low water navigation is limited to a draft of water not exceeding 2 ft. and during high water the river is practically unnavigable. The general characteristics of the Tennessee River are those of a broad tranquil stream with moderate current. The banks are usually firm and stable, while the bottom is gravel and sand, and as a whole the river presents an unusual fixity of regimen. This is broken while passing through the mountains below Chattanooga, a distance of, perhaps, 30 miles, owing to the exceedingly narrow and crooked pathway which the river has to traverse. The navigation of this section presents great difficulties at the time of low water on account of rapids and rock barriers, also at the time of high water because of the excessive velocities of flow.

At Williams Island, 10 miles below Chattanooga where the river enters the mountain section, the difficult navigation commences. The width of the river at high water through this section does not exceed 1 500 ft. and varies from 700 ft. at certain locations to the first figure. The low water width of the river is very slightly below this. The low water flow of the river at zero reading of the Chattanooga gauge is about 8 000-ft. seconds; at the high water reading, 58 ft. on the Chattanooga gauge, the flow is about 700 000-ft. seconds. It will be seen from this that any proposition

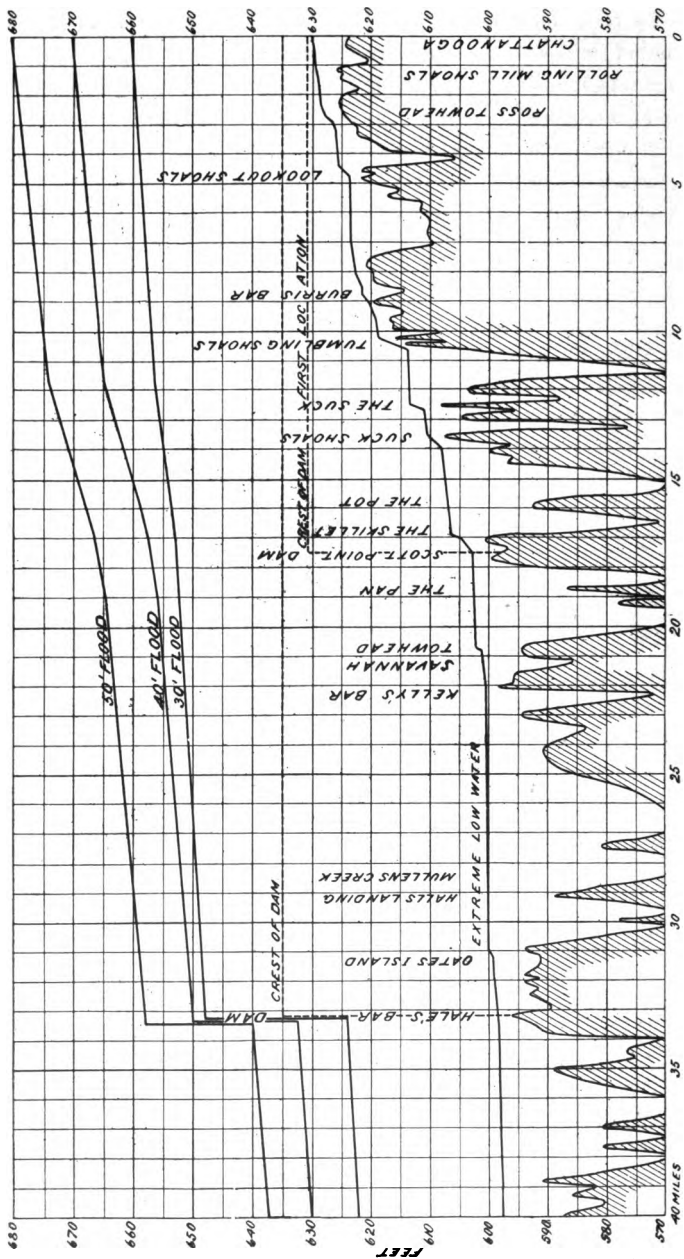
for damming or improving the river must be of a very difficult character indeed. In fact, there is practically no other river in the world in which the variation of flow is so large and the available channel so small. The maximum velocity encountered in going through the mountain section at the maximum discharge is about 19 ft. per second, while the minimum velocity at low water is approximately 1.7 ft. per second. The only work of this character which bears any relation in point of size to the improvement at Chattanooga is the damming of the river Nile at Assuan, Egypt;



but even here the maximum flow of the river is practically only 30 times the minimum flow instead of 100 times, as in the case of the Tennessee.

The government has on hand at the present time a proposition for damming the Mississippi and Missouri rivers below St. Louis, which will in point of flow compare with the conditions on the Tennessee; but the Board of Government Engineers have not as yet presented their report on this project.

The difficulties of navigation of the Tennessee River were early brought to the attention of the government, and in 1830 the first attempts at im-



LONGITUDINAL SECTION OF THE TENNESSEE RIVER.

proving the channel were made. Col. Lang, of the Corps of Engineers, made this report; similar reports were made by Col. McClellan in 1853, and other reports were made in 1854, 1868, 1890, 1892 and 1898. In all, up to about 15 years ago, approximately \$150 000 had been spent by the government in improving the channel through the mountain section; but its navigation was usually considered unsafe when the river was below the 3-ft. gauge at Chattanooga, and at any gauge beyond 20 ft. the current was so swift that none but high-powered river steamers could attempt its navigation.

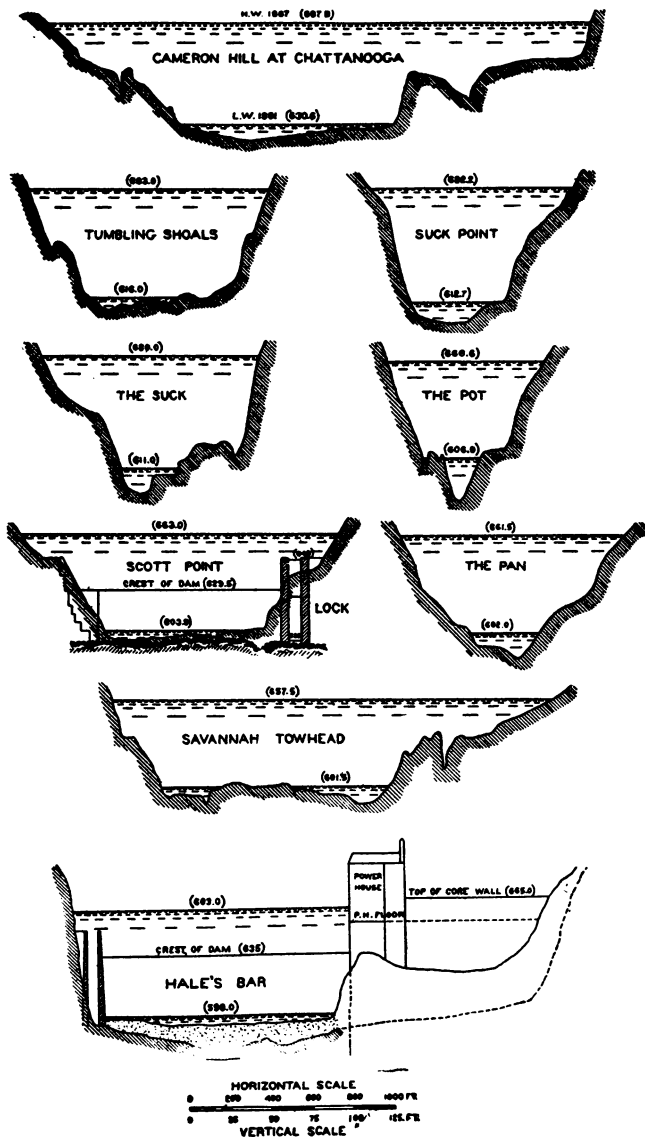
In 1891-1892 Capt. G. W. Goethals, now in charge of the construction work of the Panama Canal, made a very careful examination of the river and his report is the basis of all subsequent work which has been done.

The total low water fall between Chattanooga and Shell Mound is, approximately, 34 ft. in a distance of 38 miles. This fall is governed during the low water stages by the profile of the river bed and is concentrated where obstructions occur. The high water fall, which is, approximately, 47 ft. in the same distance is controlled by the contracted section of the mountains.

It was seen that the limit of channel improvements had been reached, and in 1890 the Board of Engineers, who were appointed to consider the improvement of the river, reported that the only practical improvement of this section would be by the construction of canals or arrangements for slack water navigation; they reported further that the expense of slack water navigation made it unworthy of consideration at that time. In 1900 the government engineers reported on a system of slack water navigation, which they estimated would cost in the neighborhood of \$1 000 000. In planning the system of slack water navigation a serious difficulty is met with, because of the enormous flood height which the river occasionally, although at long intervals, attains in the mountain section. There is no flood plane and the surface width of the river, at the maximum gauge, is not more than 1 000 ft. wide; the consequence is that the water is backed up until it has been known to attain a height of 70 ft. above its ordinary low water level in certain places in the mountains. The water during such floods backs up for many miles above Chattanooga. Of course, such floods are of rare occurrence.

An examination of the hydrographs from 1875 to 1900 shows that the stage of 35 ft. on the Chattanooga gauge is the limiting height beyond which it will not pay to attempt to provide navigation.

The Chattanooga business men early saw the advantage which would accrue to the city through the development of water power by the improvement of the Tennessee River and in 1904 they secured an act of congress.



CHARACTERISTIC CROSS SECTIONS.

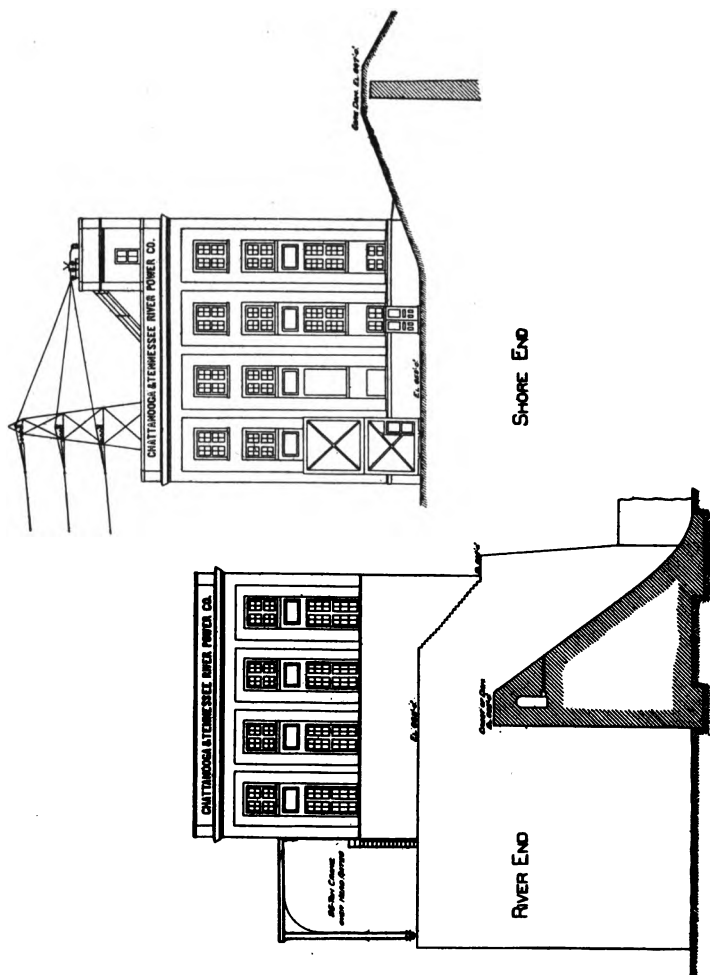
granting permission to the City of Chattanooga to build and construct a lock and dam across the Tennessee River at Scott's Point. The city, however, did not take up this franchise and a further clause of the act prompted private parties to accept what the city had refused. Mr. A. N. Brady, in connection with Mr. C. E. James and Mr. J. C. Guild of Chattanooga, took up the franchise and organized the Chattanooga and Tennessee River Power Company, which entered into contract with the United States Government for the construction and maintenance of the works.

It was found on investigation that the location of the dam at Scott's Point would not give a sufficient improvement to the river nor sufficient water power due to the backing up of the tail water at the higher stages of flow. Authorization was finally obtained for the locating of the dam at Hales Bar, 33 miles below Chattanooga, where solid rock was available for the dam foundation, and the flood plane widened out to such an extent that a rapid rise of the tail water would not be so disastrous to water developments. The head on the turbines at this place would be about 39 ft. at low water, while at a 40-ft. stage the backing up of the tail water would reduce this head to about 19 ft.

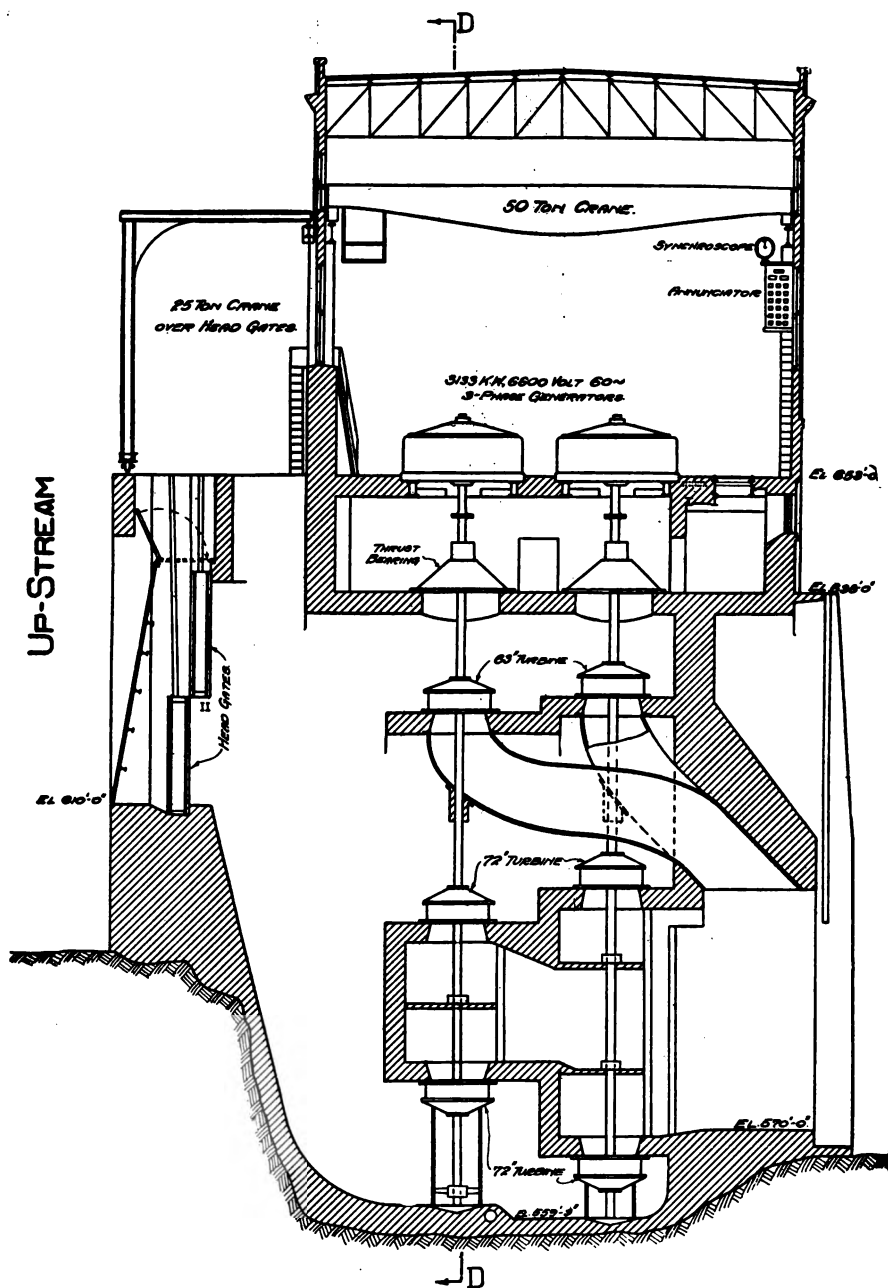
The lock and dam was designed under the directions of Major H. C. Newcomer; the designs for the water-power plant were made by Mr. John Bogart, C. E., consulting engineer of the Chattanooga and Tennessee River Power Company, while the mechanical and electrical designs have been perfected by Mr. T. E. Murray, consulting engineer, and his staff of assistants.

The hydraulic problem was of great difficulty, as the variation of flow is extremely large. The minimum flow is about 5 000 cu. ft. per second. The high water flow is, approximately, 200 000-ft. seconds, which with occasional floods rises to 320 000-ft. seconds. As a general statement it may be said that for two months of the year the flow will be between 8 000 and 16 000-ft. seconds; for about 4 months, between 12 000 and 60 000-ft. seconds; for about 4 months, between 16 000 and 60 000-ft. seconds, and for about two months, between 20 000 and 100 000-ft. seconds. During the shorter periods, of course, the maximum flow largely exceeds these figures. To secure uniformity of speed and regular output, it was necessary to place three turbines on each shaft, the two lower ones operating in periods of high head and low flow, while the third turbine was brought into play when there was more water but less available head.

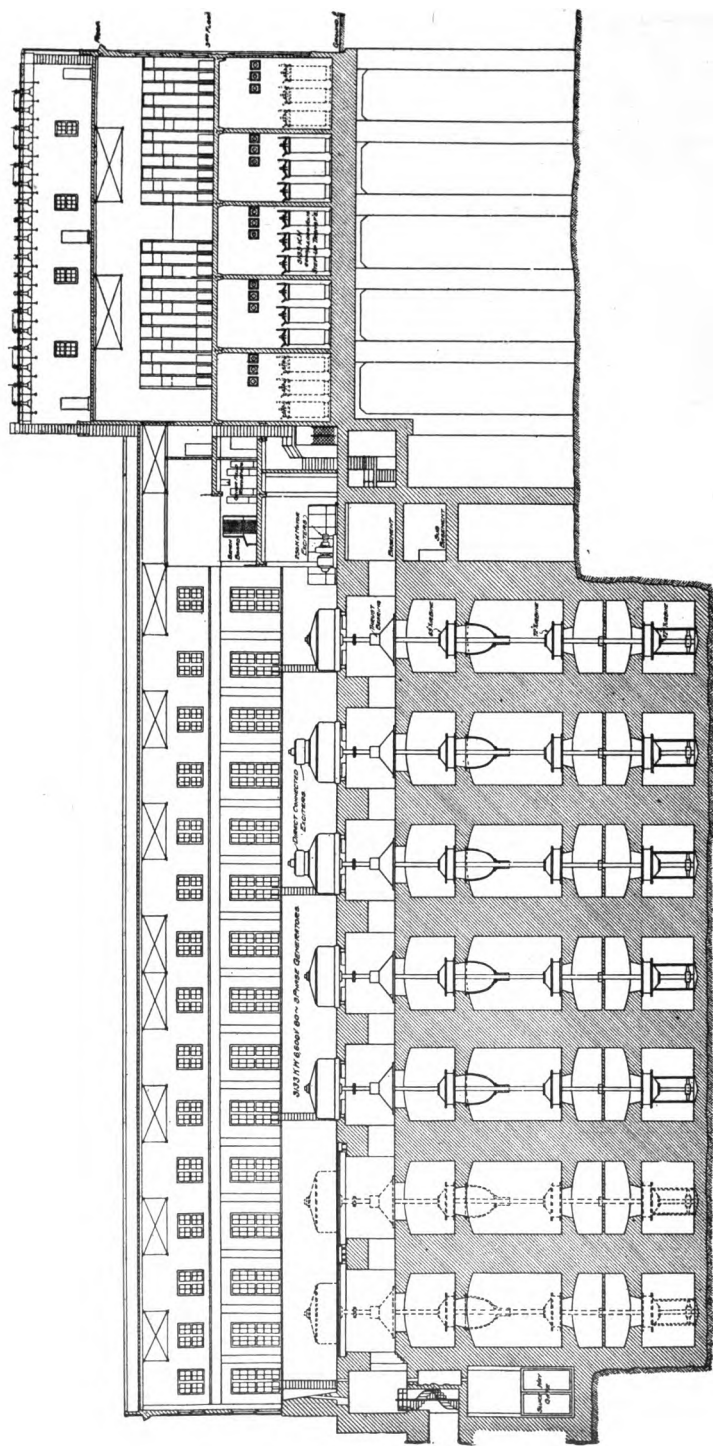
The lock and dam are built of concrete in which large stones up to 10 tons in weight have been embedded; some re-enforced concrete has also been used. The power house with its transformer house has been built of re-enforced concrete.



ELEVATION, HALES BAR STATION, CHATTANOOGA & TENNESSEE RIVER POWER CO.



CROSS SECTION, A-A, HALES BAR STATION, CHATTANOOGA & TENNESSEE RIVER POWER CO.

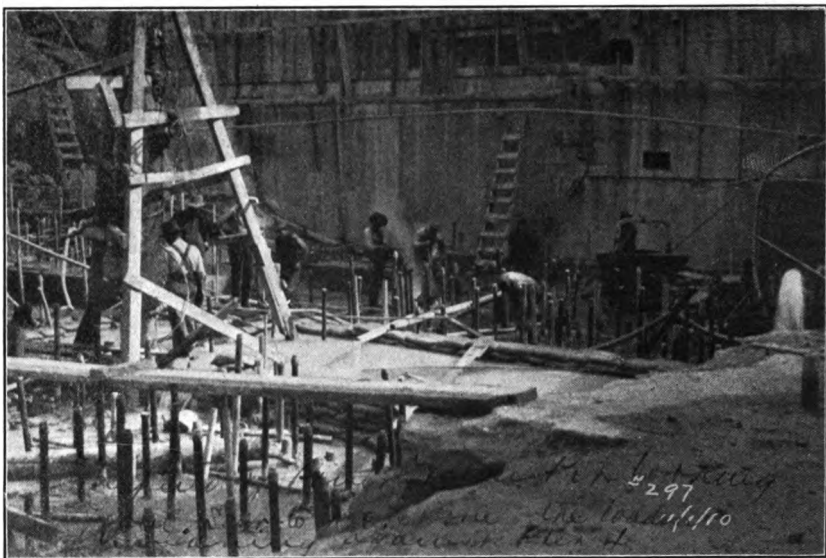


LONGITUDINAL SECTION D-D, HALE'S BAR STATION, CHATTANOOGA & TENNESSEE RIVER POWER CO.

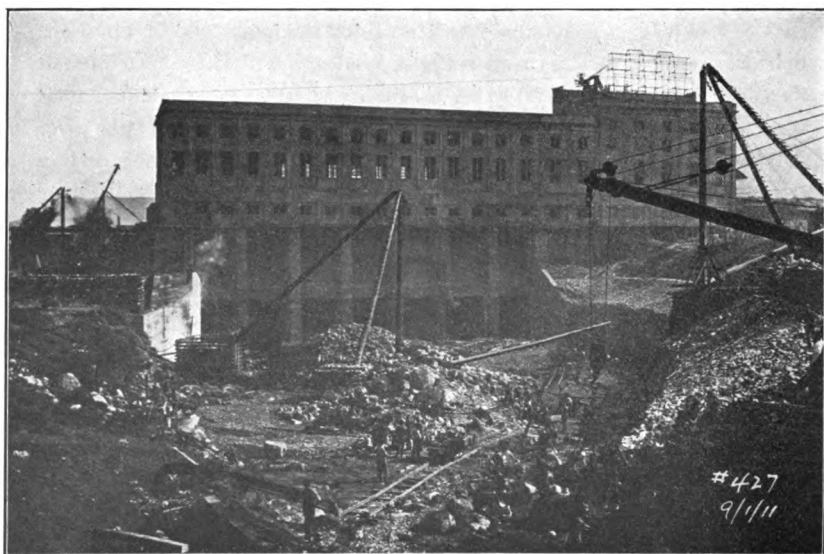
The lock which is situated on the west or right bank of the river is built against a rock bluff, has a clear width of 60 ft., and is, approximately, 312 ft. long inside. The gates are of the mitering type horizontally framed, built of steel and operated by electricity. These gates are somewhat remarkable for the head which they have to support, the difference in elevation between the two pools being about 40 ft.; each lift of the lower gates will be 34 ft. long, 59 ft. high and will weigh 129 tohs. The upper gate was built by the Baltimore Bridge Company, Baltimore, Md., and the lower gate by the Penn Bridge Company, of Beaver Falls, Pa. The lock chamber is filled by two culverts, 11 ft. by 6 ft., operated by stoney sluice gates fitted for electric operation. The dam itself is 1 200 ft. long and extends from the lock on the west side of the river to the Power House and transformer house on the east side. The crest of the dam will be at an elevation of 635 ft. and a flash board apparatus bringing the elevation of the crest up to 638 ft. will be provided. There is a passage way through the dam in which the electric conduits are carried from one side of the river to the other. In the power house a sluiceway is provided to supply water to the lower pool, at times when none is passing over the dam or through the power house.

The power station is 66 ft. wide by 353 ft. long, and in two sections, an operating building 1-story high, 220 ft. long, and a switch and transformer house 3 stories high and 133 ft. long. The operating building consists of 7 bays, each containing 2 turbine units, making a total of 14. Each unit consists of 3 turbines mounted on a vertical shaft with a generator at its upper end. Each generator has a capacity of 3 000 kw., making a total capacity of 42 000 kw. for the station. Under ordinary stages of the river only 2 of the turbines will be used for each unit, the third being held in reserve and used when there is a large quantity of water flowing, but giving a reduced head due to back water in a tail race. The 2 lower turbine wheels are 72 ins. in diameter, and the upper wheel 65 ins. in diameter. The turbines run at 112½ R. P. M. Each unit is capable of delivering 5 250 horse-power with a head of 35 ft. The contractor for the hydraulic machinery is the S. Morgan Smith Company, of York, Pa. The oiling and hydraulic control systems are being installed by L. K. Comstock & Company and the governors by the Lombard Governor Company.

The operating building rests practically on the east end of the dam and is carried down to solid rock. The switch and transformer house is supported by round concrete piers carried down to solid rock. The piers were placed by means of light sheet steel caissons sunk through the earth to solid rock, the earth being excavated as the caissons were sunk; the steel caissons were filled with concrete, the concrete piers being proportioned so



SMALL WELLS FOR GROUTING POWER HOUSE FOUNDATION.



EXCAVATION FOR TAIL RACE.

as to stand the entire load without any assistance from the light steel shell.

The operating building and the switch and transformer house are steel frame structures with concrete walls. The main floor of the transformer house is composed of reinforced concrete, and the upper floors and the roof of the transformer house and the roof of the operating building are built of flat concrete arches set between steel beams.

An electric traveling crane of 50 tons capacity is provided to handle the generator and turbines in the operating room, and a gantry crane is placed on the up-stream side of the operating building to handle the head gates.

The generating station is laid out to accommodate 14 alternating-current generators, 6 exciters, 1 exciter switchboard, 1 alternating-current lighting and power board, 1 alternating-current control board, 14 alternating-current generator field rheostats, 1 storage battery, 6 step-down transformers, 15 step-up transformers, 29 6 600-volt H3 oil circuit breakers and buses, 10 45 000-volt H3 oil circuit breakers and buses, 3 sets of multiplex lightning arresters and choke coils, and 3 sets of electrolytic lightning arresters and horn arresters.

With the exception of the storage battery all the above apparatus was manufactured by the General Electric Company, Schenectady, N. Y., and will be installed on the three floors and the roof of the generating station.

The 14 alternating-current generators are located on the main floor of the operating room, arranged in 2 rows, 7 in each row.

Each generator is of 3 000-kw. capacity, 3-phase, 60 cycle, 6 600 volts, 112.5 R. P. M., and is mounted on a vertical shaft, which is driven by three water wheels.

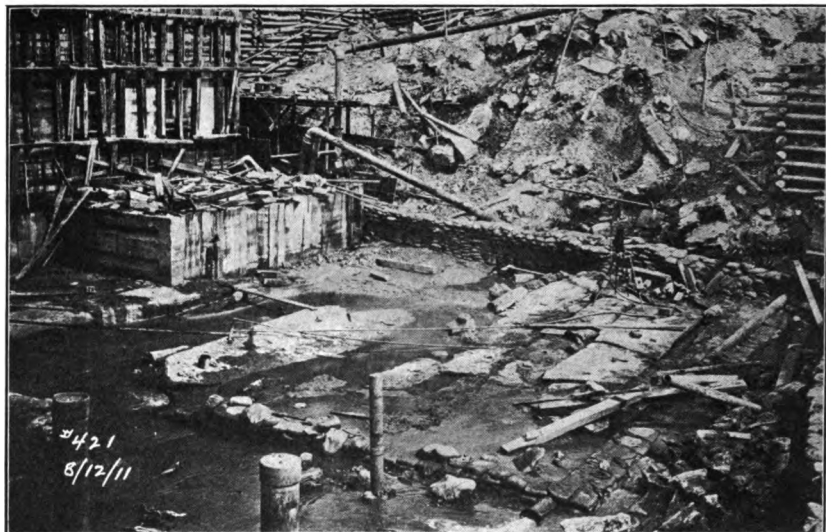
At present there will be installed only 10 generators, 2 of which will have a 100-kw. exciter, mounted on the shaft.

On the main floor of the operating room, near the switchboard, are located the other 4 exciters, each consisting of a 250-kw., 250-volt, 720 R. P. M., direct-current generator, driven by a 375 horse-power, 220-volt, 720 R. P. M., 3-phase induction motor, both the generator and motor being mounted upon a common base and coupled together.

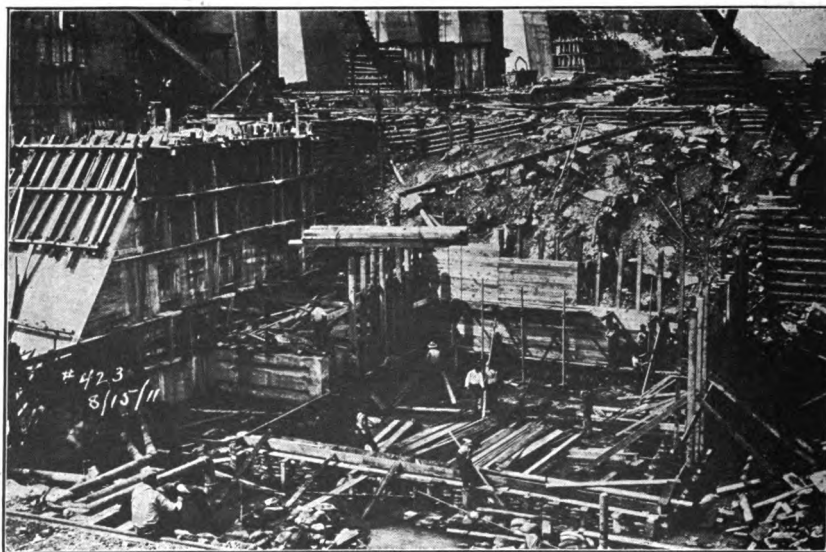
On the same floor, close to the motor exciters, is located the exciter switchboard, and the alternating current light and power board.

At the extreme eastern end of the main floor of the operating room are located six step-down transformers, each of 300-kw. capacity, 3 phase, 60 cycles, 6 600/230 volts, oil cooled. These step-down transformers are located in back of the alternating-current light and power board, but are separated from it by a fireproof enclosure.

At present only 5-step-down transformers will be installed, 3 of which will furnish alternating-current to the exciter-motors and 2 will furnish current for the station lighting and power.



READY FOR CAISSON.



SETTING CUTTING EDGE AND BUILDING FORMS.

Above the exciter board and the step-down transformers is a gallery on which is located the main alternating-current 6 600 and 44 000-volt control switchboard, from which are also operated the alternating-current generator field rheostats, located in the rear of the board.

From each of the alternating current generators, 3 single-conductor cables are run in bituminized fibre conduits, laid in concrete, to the generator oil circuit-breakers and generator buses, which are located in the north part of the first floor of the transformer house, divided from the operating house by a 12-in. thick concrete wall.

From the generator buses current is sent through oil circuit-breakers to the 15 step-up transformers, which are located on the first floor, but are separated from the switch room by a 12-in. concrete wall.

The 15 step-up transformers are grouped in 5 sets, 3 transformers to each set, each transformer being 3 133-kw. capacity, high-tension side 25 400/44 000, low tension 6 600 volts, 60 cycle, single phase, water cooled. At present only 3 sets will be installed.

The 44 000-volt current from the step-up transformers is transmitted through oil circuit breakers to the 44 000-volt buses, which are located partly on the second and partly on the third floor in the transformer house. On this floor are also located the 44 000-volt multiplex lightning arresters.

From the 44 000-volt buses the current is sent through 2 oil circuit-breakers and choke coils up on to the roof, where connections are made with the 2 transmission lines, carried on a steel tower built on top of the roof. The ends of each line are connected to horn arresters, which are located on top of a narrow house or enclosure built on the roof. From the horn arresters connections are run through "roof entrance" type insulators to the electrolytic arresters, 4 to 1 line, which are located in the above enclosure.

There is a provision made for a third (emergency) transmission line, which will not be installed at the present time.

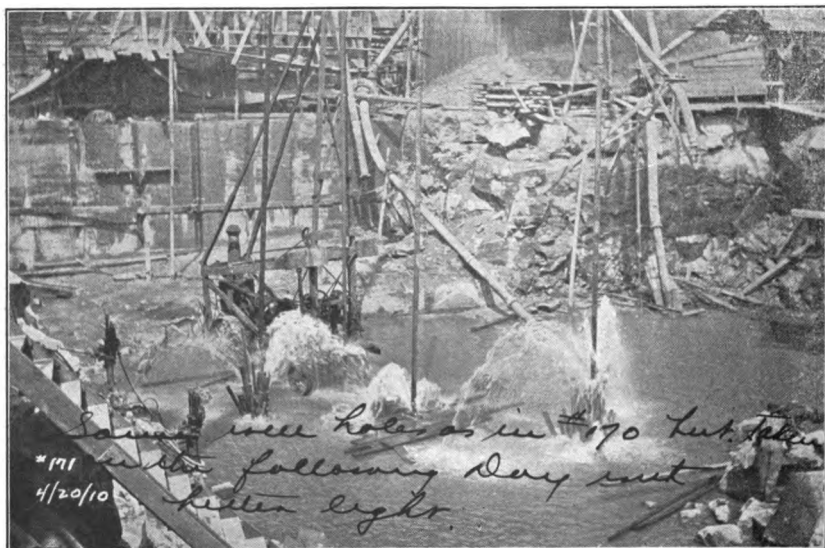
All the H3 oil circuit breakers and buses, both 6 600 and 44 000 volts are installed in compartments built of reinforced concrete.

All the main 6 600-volt connections are cables with 2/32 in. best rubber, 8/32 in. varnished cambric and 2 waxed braids. All 44 000-volt connections are bare copper tubing of 1-5/16 in. outside diameter. The connections between the horn and the electrolytic arresters are bare copper tubing of 15/16 in. outside diameter.

The transmission lines leave the generating station on top of the roof at almost a right angle to the long side of the building, are carried to the sub-station on 175 steel towers, exclusive of the 2 steel towers, 1 on top of the generating station and a similar tower on top of the sub-station.



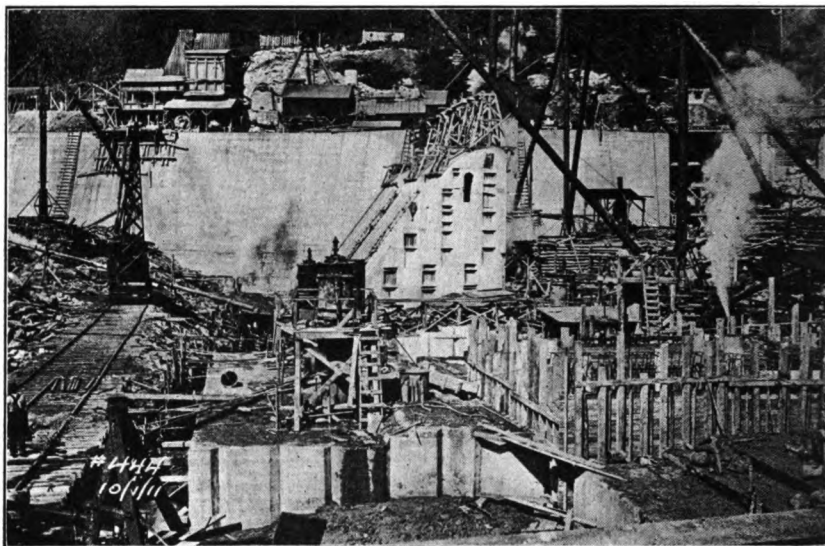
LEAK IN POWER HOUSE FOUNDATION.



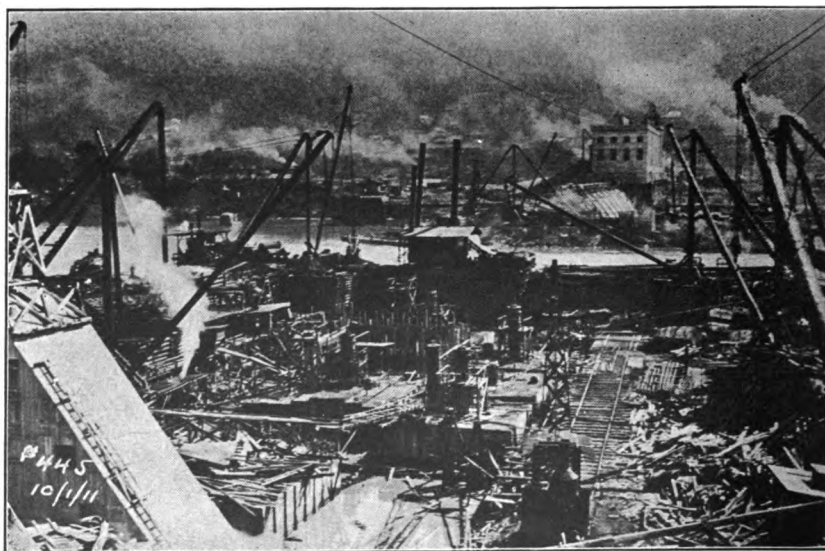
SPOUTING WELLS IN POWER HOUSE FOUNDATION.

The work on the east side of the river includes the power and transformer houses and the excavations for the head bay and tail race. The river bank was at about El. 630 and the top of the rock at about El. 595 above sea level. The lowest point in the power house is at El. 559.25, except a pipe line for emptying the bays which goes about 2 ft. lower. All of this rock excavation was taken out with derricks. These were stiff leg at the beginning of the work but some of them were changed to guyed derricks as the work proceeded and as the excavations around them were taken out. The bottom of the tail race at the power house is at El. 570, but slopes up rapidly to 576 and then slopes gradually to the surface of the rock at the lower end. The head bay is excavated to El. 610.

In the 2 bays at the east end of the power house there was no trouble whatever with water, but in the rest of the excavation large quantities of water came up through the natural crevices in the rock. At first, before the excavation had reached the lower grades, an attempt was made to pump the water out during the progress of the work and to keep it down by pumping, but the amount increased so fast that something had to be done to stop it. At one time a channel machine was used to cut a channel on the north side where there seemed to be evidence that the water was coming in from the upper side of the dam, but as the excavation was carried deeper it was seen that the water was coming mainly from the bottom. Well drills were then secured and placed at work in the west end of the power house. These put down holes with a diameter of 6 ins. and they could be carried to any depth; some on the dam site were carried 50 ft. A number of holes were put down in the bottom where there was evidence that crevices and fissures would be met. As the amount of water coming in increased and became too much to handle with the pumps, the pit was allowed to flood with water to the level of the river; pumps would then be placed so as to throw water into the pit so as to raise the level inside the coffer-dam a little above that in the river. Before flooding, pipes had been put into the well holes and carried up so as to be above the level of the water after flooding; these pipes were of the same size as the well holes and were bushed down at the top to 2 ins. and cement grout was forced into the holes through the pipe using a small grouting machine. These machines consist of a horizontal cylinder with paddles in it; the cement and water were put in at the top, the top door would then be closed and air pressure put on the inside. The paddles were turned by air and after turning the cement and water together a few times a valve on the discharge end would be opened and the grout forced down into the pipe with the air pressure. The air was secured from the compressor plant on the work and a pressure of about 80 or 90 lbs. could be obtained if necessary. Ordinarily only a few pounds pressure would be used, just enough to force the grout out of the pipe and



CAISSONS COMPLETED AND UNDER CONSTRUCTION.



COFFERDAM WITH CAISSONS, WEST SIDE.

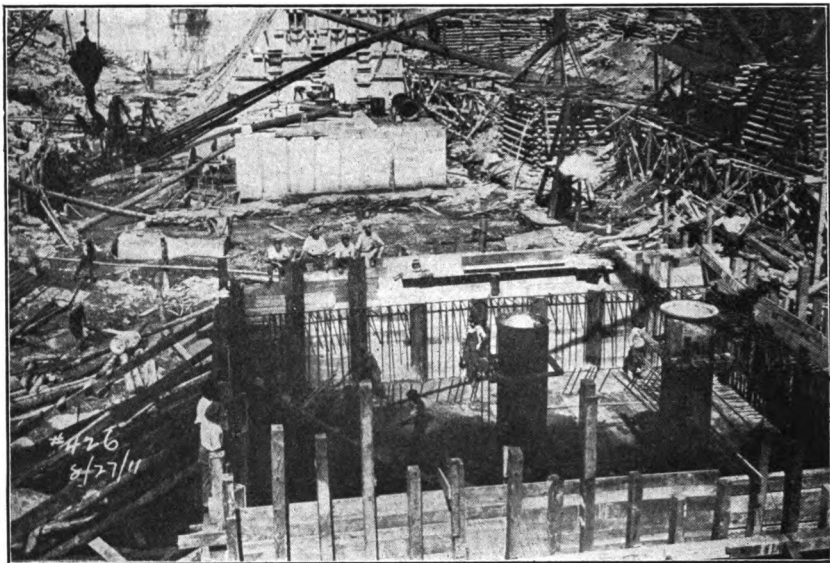
well into the hole. About 12 000 barrels were used in the power-house foundation in this manner.

After the end of the power house had been excavated to grade there was still trouble with the water coming up through the bottom whenever test holes were put down. In order to fill all openings and crevices in the rock immediately below the bottom of the power house a large number of drill holes were put down with the ordinary percussion drill making a hole 2 ins. in diameter, water would be forced into the hole so drilled, after pipes had been driven into them. After washing the holes thoroughly they were filled with cement grout. All of the grout used was of neat cement as it was feared that if a mixture of sand and cement were used they would become separated after being put into the water in the crevices and would not accomplish the result of filling and closing the holes and the cutting off of the water and leaks.

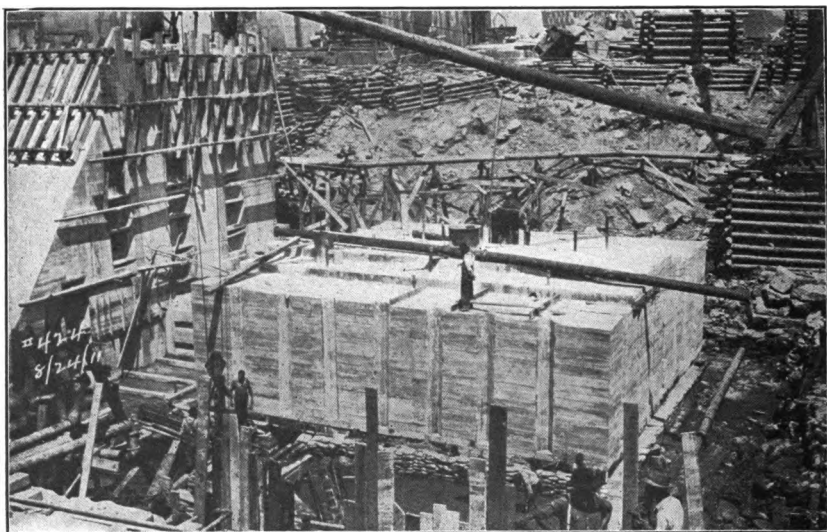
The dam on the east side of the river covering about one-third of its length was enclosed in a coffer-dam divided into 2 sections by a cross coffer-dam. The same trouble was met with here in connection with the bottom. At first the well drills were used to stop the water by drilling and grouting as in the power house. Later when the bottom was about secured it was covered with small holes put down with the ordinary percussion drills and then filled with grout as in the power house.

On the west side of the river about one-third of the width of the river was enclosed in one section of coffer-dam. Before any material was excavated here the well drills were put at work and put down a large number of holes over the entire bottom. A large proportion of these holes could not be driven as far as was desired owing to the fact that after the drill had passed a crevice, sand and gravel would drop into the hole at the side of the drill and prevent the carrying of the hole any further. Some of the holes were carried far enough to do some grouting, but the effect was not as good as was desired. One reason why the well drills did not work as well on the west side as on the east is the fact that pumping in the coffer-dams on the east side had been carried on for some time before the well drills were tried. This supposedly washed a large amount of sand and gravel out of the crevices leaving them free to carry water better. As the holes were washed out they did not contain material to drop into the holes and interfere with the progress of the drills.

About 100 ft. of dam foundation was secured on the west side by the use of the holes for washing and filling the crevices as on the east side and in the power house. This summer a new method was tried to get the bottom and it is still in operation. The rest of the bottom inside the coffer-dam has been covered with 14 caissons. These are of different sizes, but the most of them are either 40 x 40 ft. or about 30 x 30 ft. The first part



SETTING AIRLOCKS.



COMPLETED CAISSON.

of the operation of building and placing a caisson is the location of the cutting edge. This is built up of steel plates. On this are built forms. Those for the roof slope back from the cutting edge so as to make the roof about $4\frac{1}{2}$ ft. above the cutting edge. The forms are then filled with concrete, the roof being about 8 ft. thick. The caissons are reinforced with 1 in. rods, both vertically on all 4 sides and on the top and bottom. Two locks are provided through the top one for the men and the other for muck. Pipes for air and water are also provided. The caissons are built in place and then after the air is applied, the material in them, earth and rock, are removed. Up to the present time the air pressure that has been carried in the caissons has not exceeded 10 lbs. As the work progresses the caissons are lowered in the usual manner. After all the loose rock has been removed and a good foundation secured the caisson is thoroughly cleaned and the concrete is placed in it up to the cutting edge under air pressure. This is carried up sufficiently to seal the cutting edge and then after setting the air is removed and the rest of the caisson is filled under atmospheric pressure.

The middle section of the river is now being coffer-dammed and it is intended to use the caissons here also.

At the present time the power and transformer houses are completed and the hydraulic machinery is being installed. The dam for about 430 ft. on the east side of the river is complete except for 9 gaps, each 20 ft. long, that have been left to take the water while the middle portion of the river is coffer-dammed. The bottom of these gaps is at El. 600, which is $1\frac{1}{2}$ ft. above the low water mark at the work. On the west side of the river the dam foundation is in for 100 ft. from the lock and the rest of the bottom of the coffer-dam is covered with caissons. Gaps have been left in the above 100 ft. and will be left in the rest of this portion of the dam for the same reason as on the east side. The middle portion of the river is now being coffer-dammed.

This work is being done under government inspection. The work was started while Maj. Newcomer was in charge of the district. He was succeeded by Maj. William W. Harts, and Maj. Jadwin is now the officer in charge of the district; Maj. C. A. P. Flagler was temporarily in charge of the district at 2 different times. The United States Junior Engineer on the work is Mr. G. H. Tisdale. The work is under the direct charge of Mr. John Bogart, consulting engineer, with Mr. George F. Rowell, Mem. Brooklyn Engineer's Club, as resident engineer. The power house and electrical installation is in charge of Mr. T. E. Murray, consulting engineer, with Mr. B. T. Burt as superintendent. The present contractors for the dam are Messrs. Jacobs & Davies, with Mr. C. J. Crowley as superintendent.

THE EXHIBITION

The first annual exhibition of engineering materials, processes and models took place in April, from the 17th to the 22d.

The lower floor of the clubhouse was filled with exhibits, and the smoking room with plans and views showing the progress of the work on the Fourth Avenue subway. The library contained exhibits of engineering instruments, books, etc.

Ten minute talks by exhibitors were a feature, and the attendance was very gratifying, the audience displaying a great deal of interest.

Engineering News, commenting editorially on this exhibition, said, in part:—"We suggest, therefore, that the example of the Brooklyn Engineers' Club is one well worthy of imitation. If the engineering organizations in a city will take up such a project in thoroughgoing fashion, organize an exhibition containing things of real interest and novelty, conduct it along high-class lines, and open it to the general public, they can bring engineering and engineers into more prominent public notice, and do more real good to their profession than they can in the entire year's work of holding cut-and-dried meetings in the old-fashioned way."

The U. S. Wood Preserving Co.'s exhibit showed paving blocks, treated and untreated. Blocks removed from the city streets after eight years' continuous service. Views of this type of pavement in use in cities throughout the country and in Europe. Mr. Alexander Reid, of this company, described the process of manufacture and the history of the industry in this country.

The Heenan Destructor Co. showed a model of a refuse destructor of the type built by this company for several cities. A representative of the company, with the aid of the model, described the method of operating these destructors and outlined the advantages claimed for them.

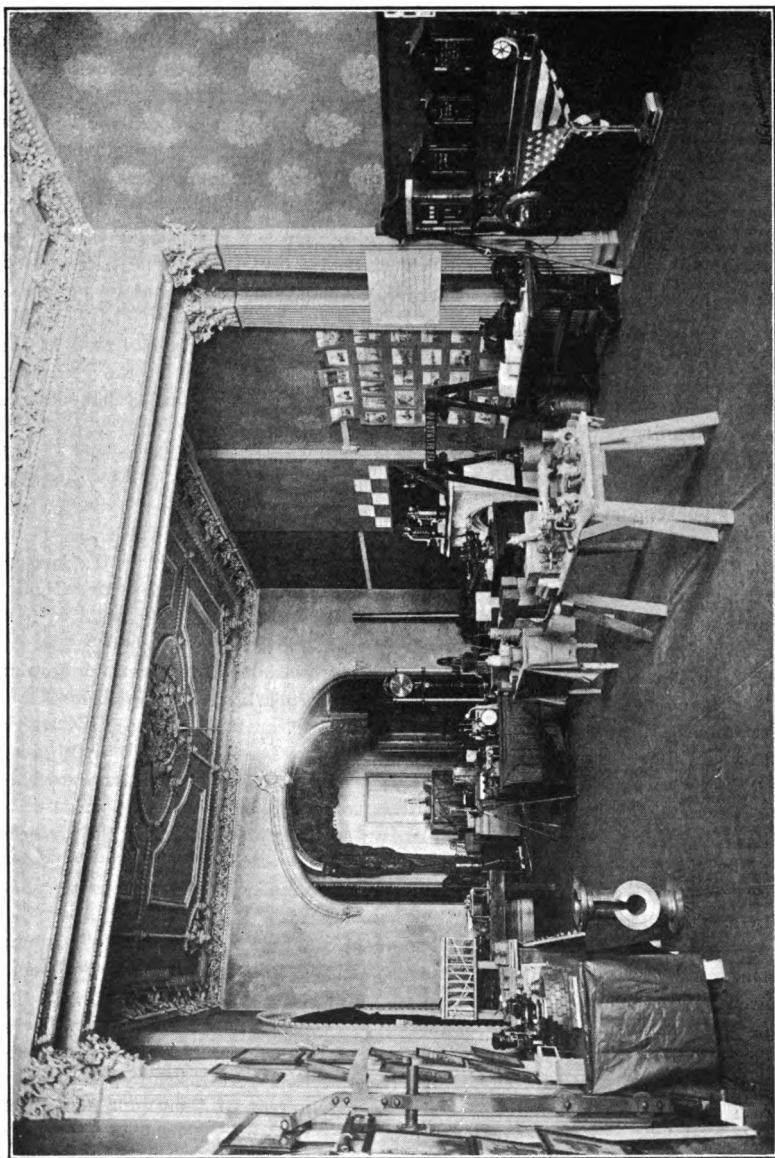
The Lidgerwood Mfg. Co. showed views of the Lidgerwood cableway in use on the Panama Canal, and some of the improvements of the apparatus used, which enabled the speed and the efficiency to be raised considerably.

The Gamewell Fire Alarm Telegraph Co. had a complete fire alarm system in operation. A representative of the company was in attendance and showed the construction of the instruments, and in a short lecture traced the development of the apparatus from the crude original instrument to the present highly efficient one.

The Pyrene Mfg. Co.'s exhibit was a glass tank filled with Pyrene, in which was submerged a small motor connected with naked wires. Two electric lights were kept burning in this liquid for a week to show that the liquid would not short-circuit the light or damage the insulator. The construction of the containers was also shown.

The Chandler & Floyd exhibit showed sections of American Ingot Iron pipe which had been subjected to a number of tests to show the non-corrosive qualities of this material.

The Turner Construction Co. showed a view of "Turner City." A pic-



VIEW OF EXHIBITS ON LOWER FLOOR OF CLUB HOUSE.

ture of all the buildings erected in reinforced concrete by this company. Mr. Mellor, of this company, described this exhibit.

The Concrete Steel Co. showed a model of the type of floor for factory buildings designed by this company. Mr. Pouch, of this company, gave some interesting data on the cost and the use of this floor.

Nelson Goodyear, Inc., had a complete oxy-acetylene welding and cutting outfit on exhibition and gave some very interesting demonstrations of the uses to which this apparatus is adapted.

The Grinden Art Metals Co. showed a Grinden steel door, and sections showing the construction of these doors. Mr. Grinden, a member of the society, has a paper covering this subject very completely, in this volume, page 139.

William T. Donnelly showed a working model of a dry-dock (shown on stage in picture of the exhibit). This dock is of a new type patented by Mr. Donnelly, and a very able article, covering all features of its construction is to be found in Volume 9 of these Proceedings.

The Wire Inspection Bureau had an exhibit of instruments used in the testing of insulated wire. Mr. H. T. Wreaks, secretary of the company, was in charge of this exhibit and made a number of tests to demonstrate the reliability of the methods used.

The Rail Joint Co. showed Weber, Wolkhamer, and other types of rail joints manufactured by this company and a representative of the company explained the uses of each type and the advantages of each type for the service it was designed for.

The John Simmons Co.'s exhibit showed a Standard hot-water heater, a new type, invented by Mr. J. C. Meem, and a Simmons sectional pile. Mr. Meem described the heater and gave some results of tests made with it which showed it to be an exceptionally economical device.

The Nash Engineering Co. exhibited a Nash hydro-pneumatic blower. This machine is entirely new and had never been exhibited before. Mr. Nash, the inventor, and the president of the Nash Co. outlined the uses for which this machine is especially adapted.

The Corrugated Bar Co. exhibited types of reinforcing rods and sections of Cortile flooring manufactured by this company. Mr. Atkinson, in describing this exhibit, gave some valuable data covering the uses and cost of these materials.

The Jefferson Union Co. had a handsome display of the various types of hydraulic fittings manufactured by the company.

The exhibit of the Chas. A. Schieren Co. was a roll of their well-known Duxbak waterproof leather belting, which was looped over a supporting arch with the lower end immersed in water. At the close of the week, the part of the belting that was immersed, showed no change whatever, thereby demonstrating the truth of the statement of this company, that Duxbak belting is absolutely unaffected by water. Mr. E. P. Atkinson, representative of the Chas. A. Schieren Co., stated that hundreds of thousands of feet of this brand of belting are in use throughout the entire world doing service in all climates and under all conditions to which driving belts are subjected.

The M. W. Kellogg Co.'s exhibit showed a section of a chimney built with small models of the radial brick which this company uses. Also dif-

ferent types of flanges and fittings manufactured by this company and used in modern power plant construction. Messrs. Austin and Menton, of the company, described the advantages of the products shown in a brief but very interesting talk. Above a number of views of chimneys built by this company was a sign which caused much amusement. It read, "A steeple is not necessarily more pious than a smoke stack."

The Hayward Co. exhibited models of the types of buckets manufactured by this company and had the models operated in coal, sand and other materials. Among them was an old battered brass model of a clam shell bucket which had been used by the Cranford Co. in building the foundations of the Centre Street subway loop. This bucket was the smallest ever used for big work. A tub filled with stone which had been removed from the subway foundations was placed below the bucket and the old model, though badly battered up, would pick up sections of stone as readily as ever. The use of this model for actual work lead to the development of a small bucket for this work.

Jenkins Bros. showed a number of special valves for steam heating manufactured by this company under patents obtained by Mr. Jas. A. Donnelly. Mr. Donnelly took charge of this exhibit and described the experiments and tests which led to the development of this type of valve.

Manning, Maxwell & Moore exhibited a number of steam specialties: injectors and safety valves, with sections of casing removed to show the mechanism of the valves; and globe and angle valves for high pressures.

On the library floor the Public Service Commission had a complete layout of plans and photographs showing the progress of the work on the Fourth Avenue subway.

The exhibit of Buff & Buff consisted of five of the latest types of instruments made by this company. This exhibit was under the personal charge of the New York representative of the company, and was a very handsome one, attracting a great deal of well-deserved attention.

The exhibit of the Brooklyn Edison Co. showed pictures of the interior of the main generating station, and also some views of the apparatus on the premises of some of its largest customers. A new contract for selling electric power, based on the maximum demand, has been recently published, and the various methods of obtaining the customers' maximum demand were illustrated. A light demand indicator was shown under operating conditions, so that the lagging or dash pot effect of the instrument could be observed in comparison with an ammeter. Automatic records were also shown taken from graphic watt meters and the method of averaging the maximum for a period of fifteen minutes.



JOHN J. McLAUGHLIN.

JOHN J. McLAUGHLIN*

DIED JANUARY 19, 1911.

John Joseph McLaughlin was born September 16, 1860, in the village of Jamaica, Long Island.

Mr. McLaughlin was educated in the public schools in Jamaica, and graduated with the degree of B. S. and C. E. from the New York University, in 1879.

From the time of his graduation to 1887 he was in charge of the work of R. L. Waters, a city surveyor of Manhattan, who, at that time, was making the surveys for all the large parks in the Borough of Bronx.

In 1887 he opened an engineering office in the 26th ward (New Lots), Brooklyn, where he did considerable municipal, as well as private work.

In the year 1891 he removed his office to Jamaica where he, with several other influential men, organized the agitation of "good roads"—which since has become world-wide.

During the years 1892 and 1893, the town of Jamaica, under his supervision, built about 40 miles of macadam roads; and in October, 1893, he was appointed County Engineer of Queens County, which position he held until December 31, 1898—the date of the county and city consolidation. During this time the county and town municipalities built, under his supervision, nearly 400 miles of macadam roads in the county, and at the time of consolidation, the Queens County system of roads was the finest in this country.

Mr. McLaughlin was the Engineer for the construction of the Grand Street and Meeker Avenue bridges over Newtown Creek, between Kings and Queens counties. He also was the engineer, for the Jamaica Sewer Commission, under whose jurisdiction the sewers were constructed in the village of Jamaica.

The President of the Borough of Queens in 1902 appointed him Consulting Engineer of the Borough, which position he held until June 30, 1910, when he resigned.

For 30 years he had been a tireless worker at his profession; and although a very busy man, he always had time to listen and advise the younger members of his profession upon intricate problems which confronted them.

The engineering profession has lost a prominent member and a loyal supporter, and his acquaintances a warm friend.

He was a member of the American Society of Civil Engineers, Brooklyn Engineers' Club, Municipal Engineers of the City of New York, and a large number of fraternal, social and political organizations.

A widow, Adelaide M. McLaughlin, and eight children survive.

*Memoir written by Mr. R. R. Crowell.



JOHN G. OULD.

JOHN GEORGE OULD

DIED DECEMBER 21, 1911.

John George Ould, who died at his home in Brooklyn, on December 21, 1911, was one whose personality will not soon be forgotten. While quiet, even retiring, by nature, he still seemed to exert an unconscious influence which attracted men to him.

He was born on April 2, 1863, in Falmouth, England, and received his early education in English private schools near his home. Later, he spent 3 years in the Science and Art School at Kensington, completing the course in engineering. Having served his apprenticeship in English shops, he became a marine engineer; and for 7 years, while acting in this capacity, had an opportunity to see many of the port cities in the East.

Mr. Ould came to New York in 1890, and for some years occupied positions as mechanical engineer. During this period he was improving every opportunity by study and close application that he might be equipped to do both larger and better work. From 1898 until the day of his death, he was Superintendent and General Manager of the Polhemus Memorial Clinic (Henry and Amity Streets, Brooklyn, N. Y.). Mr. Ould gave such scrupulous attention to the supervision of this magnificent plant that the most casual visitor did not fail to recognize the high standard of efficiency which was maintained.

Mr. Ould was a member of the Brooklyn Oratorio Society, an Associate Member of the American Society of Mechanical Engineers, a Corporate Member of the Brooklyn Engineers' Club, a Member of Sandolphin Lodge, F. & A. M., and was Vice-President of the Institute of Operating Engineers.

It would be difficult to find a more enduring memorial to Mr. Ould than those young men, who, under the influence and guidance of his strong, yet kindly personality, have risen to positions of importance and trust.

To Members of the Brooklyn Engineers' Club

Advertising literature, giving details and cost data regarding the product of the advertisers whose advertisements appear in this volume, is on file in the trade section of the library files. Additions to these files will be listed semi-annually.

Any catalogues which members desire to use will be placed on file on request.

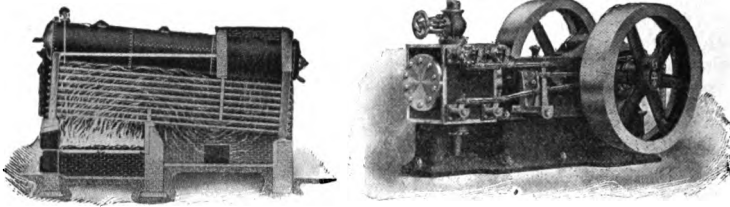
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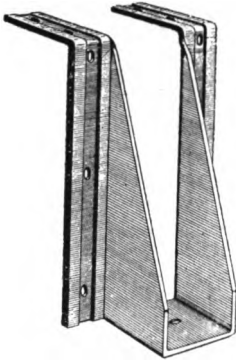
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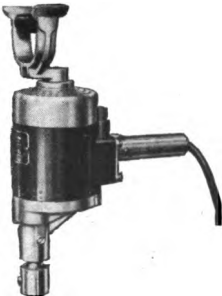
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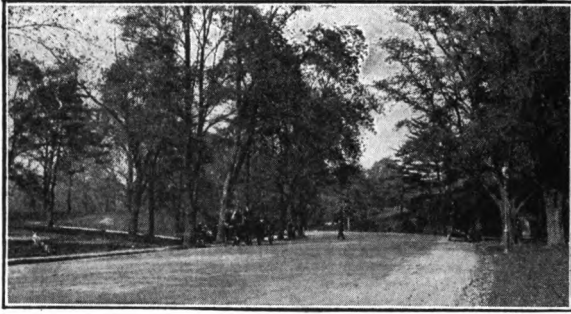
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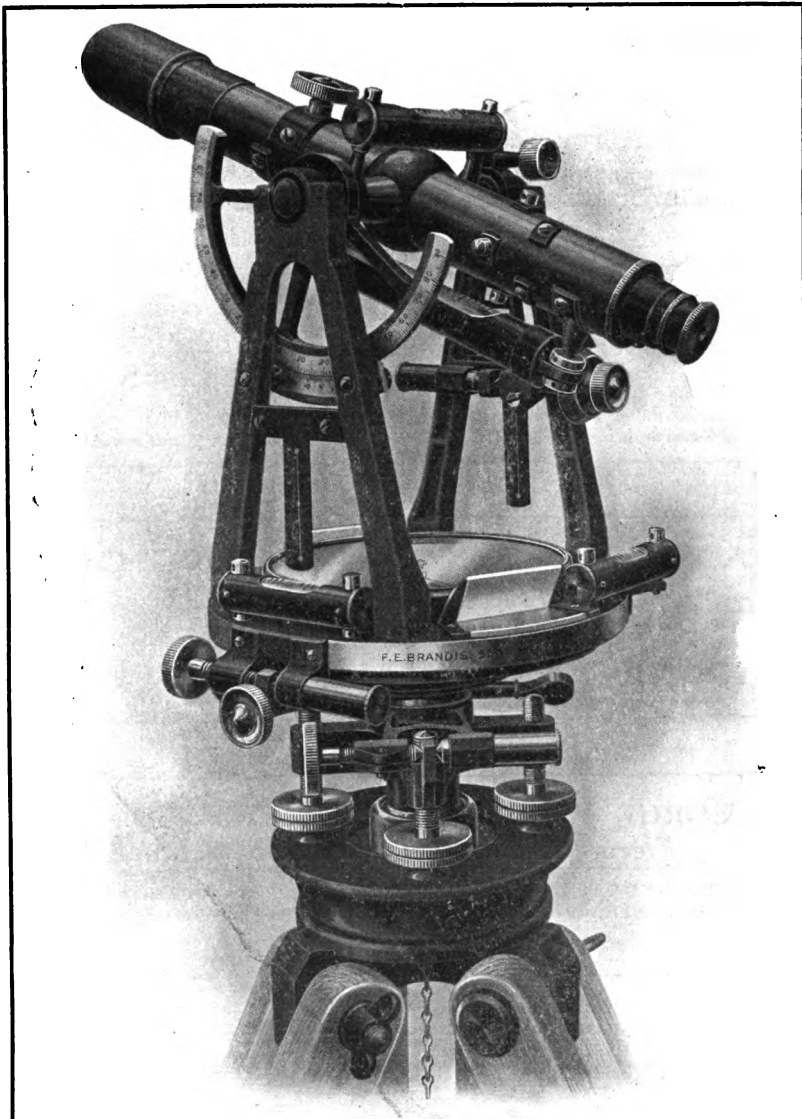
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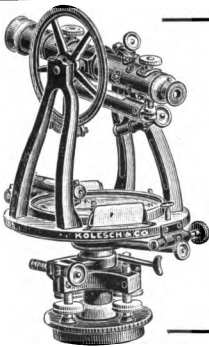
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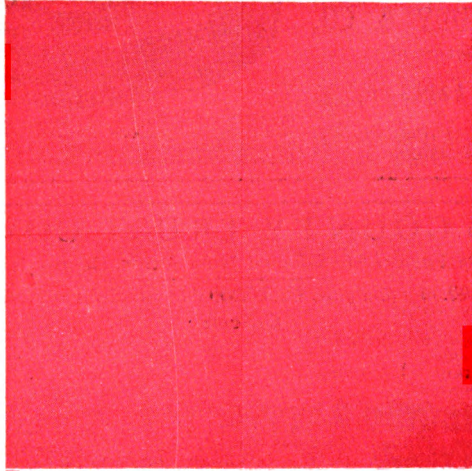
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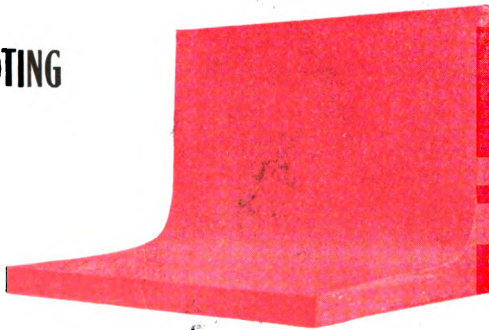
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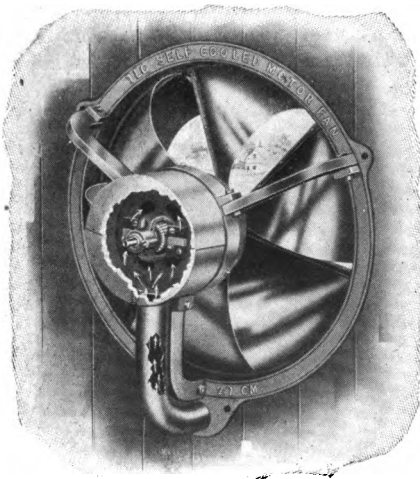
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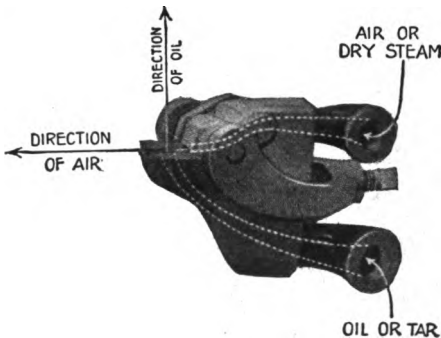
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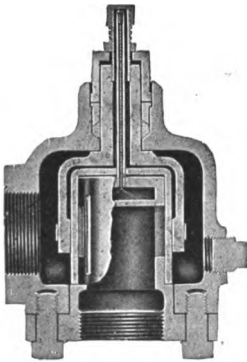
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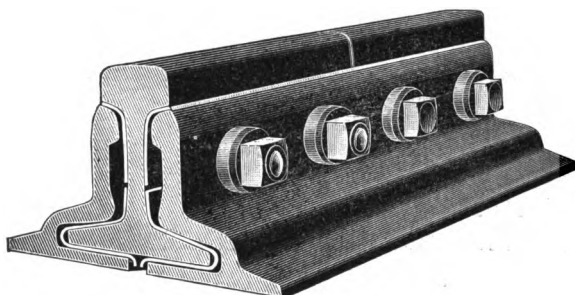
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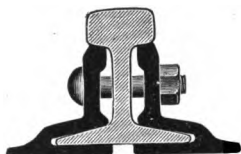
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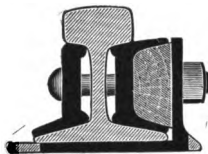
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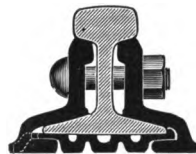
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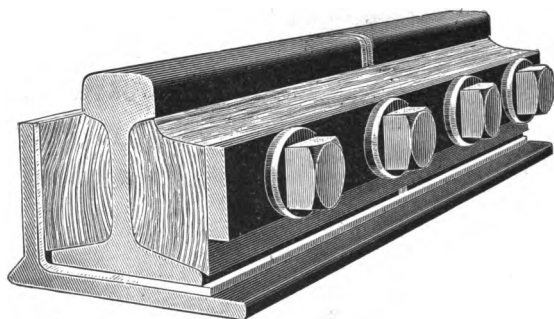


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